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COMPRESSED AIR

A MONTHLY MAGAZINE DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIR

Vol. XI OCTOBER, 1906 No. 8

THE C. & G. COOPER COMPANY

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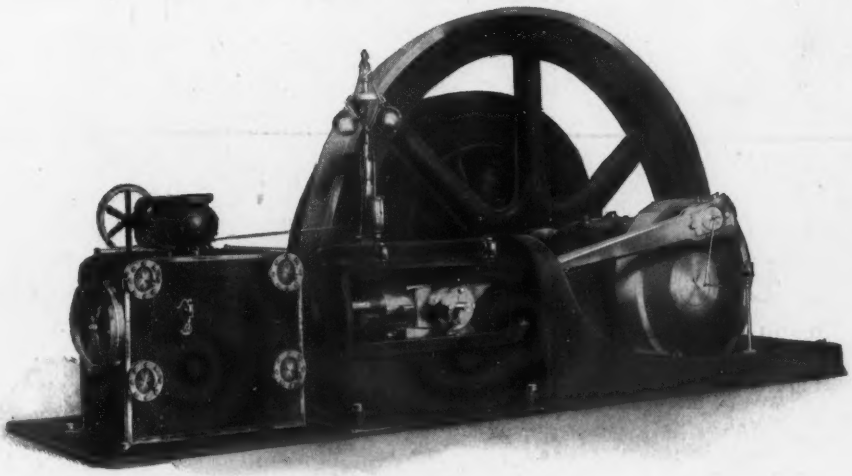

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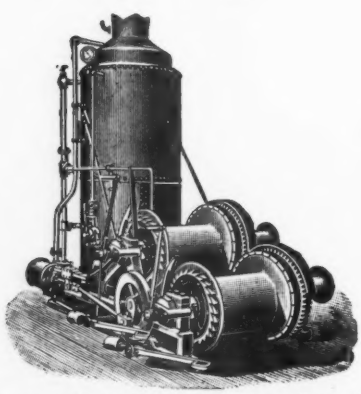

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COMPRESSED AIR

Established 1896.

A monthly magazine devoted to the useful applications of compressed air.

OCTOBER, 1906.

VACUUM PECULIARITIES.

WRITTEN FOR COMPRESSED AIR BY EDWARD F. SCHAEFER, M. M. E.

To the Editor of COMPRESSED AIR:

Dear Sir:—There are various points in the paper "Vacuum Peculiarities" which have occasioned more or less comment, and so as to modify the opinions already expressed and to secure further information on the subject, I would suggest that the paper be opened to your readers for discussion.

EDWARD F. SCHAEFER.

Vacuum is space devoid of matter.

In practice a perfect vacuum cannot be obtained. Even with the excellent compressors and suction pumps in operation to-day, an approximation only to the ideal vacuum is possible.

Moreover, a perfect vacuum is not necessary in dealing with the infinite problems in engineering that are up for discussion each day. Of course, the perfect is always desirable, but the partial is sufficient.

The engineer understands vacuum to mean a condition of matter where the attending pressure is below atmosphere, and the usual forms of matter with which he has to deal, in connection with vacuum, are gases such as steam and air. The pressure of the atmosphere at sea-level is 14.75 pounds per square inch; it is evident then that the range of pressures under which vacuums exist is between zero pounds per square inch absolute and 14.75 pounds per square inch absolute.

The degree of vacuum is commonly expressed by inches of mercury; thus, when air in a vessel is subjected to an absolute pressure of 6 pounds per square inch absolute, it is said that the gas has a vacuum of 17.7 inches of mercury (17.7" Hg). At 14.75 pounds or at atmospheric pressure, the vacuum is zero inches, and at zero pounds the vacuum is 29.9 inches of mercury.

Curious as it may seem, it takes more power to maintain a vacuum of 9 pounds absolute than it does to maintain one of, say, 0.5 pounds per square inch absolute. Obviously it takes no power whatever to move a piston back and forth in a perfect vacuum, and further it takes no power to move a piston in *no* vacuum or at atmospheric pressure (neglecting friction). Between these extreme points it takes more or less energy, depending upon the pressures.

The expression which follows must at first sight appear absurd.

"It takes more power to maintain a vacuum of 7 pounds absolute than to maintain one of 1½ pounds, since it takes no power (except friction) to move a piston back and forth in a perfect vacuum; it also takes no power to move a piston in *no* vacuum since there will be atmospheric pressure on both sides of the piston."

To the author this statement appeared so peculiar that he made a detailed investigation of it and worked out the horsepowers for both single and two-stage compression, between the limits of zero pounds per square inch absolute and 14.75 pounds, taking increments of one pound. The fact found was that the maximum horsepower for single stage compression is for compressing between 4 and 5 pounds to 14.75 pounds, and for two stage compression the maximum was found to lie between 5 and 6 pounds pressure.

To determine exactly where these points fell, the Calculus was employed, and it was discovered that the maximum horsepower for simple compression is required when the vacuum pressure is 4.521 pounds per square inch. In the case of two-stage compression the maximum horsepower is necessary when the initial pressure is 5.004 pounds.

The quotation above was therefore found to be correct in expression, although incorrect in numerical values.

Horsepower whether single or two-stage is expressed by

$$\text{H. P.} = 0.00436 \text{ M. E. P.} \quad \ldots\ldots (1)^*$$

In this expression M. E. P. signifies mean effective pressure.

For single stage compression

$$\text{M. E. P.} = 3.45\ P_v \left[\left(\frac{P_a}{P_v}\right)^{0.29} - 1\right] \quad \ldots\ldots (2)^*$$

For two-stage compression

$$\text{M. E. P.} = 6.90\ P_v \left[\left(\frac{P_a}{P_v}\right)^{0.145} - 1\right] \quad \ldots\ldots (3)^*$$

In these equations both P_v and P_a must be expressed in pounds per square inch.

P_a = 14.75 pounds per square inch; this is atmospheric pressure at sea level and is a constant.

P_v = pressure of the vacuum desired.

These formulae were employed in securing the table showing the M. E. Ps and H. Ps for both single and two stage compression.

To determine the exact location of the max-

*See "Derivation of Formulae for Simple and Stage Compression" by E. F. Schaefer. *Compressed Air, Vol. XI. No. 1.*

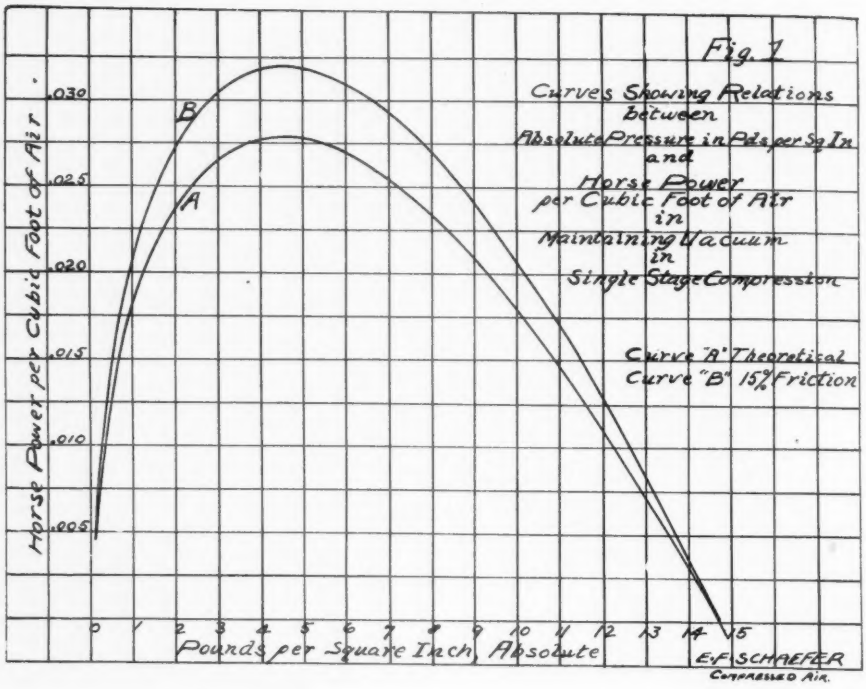
Fig. 1
Curves Showing Relations between Absolute Pressure in Pds. per Sq. In. and Horse Power per Cubic Foot of Air in Maintaining Vacuum in Single Stage Compression
Curve "A" Theoretical
Curve "B" 15% Friction
Horse Power per Cubic Foot of Air
.030
.025
.020
.015
.010
.005
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Pounds per Square Inch, Absolute
A
B
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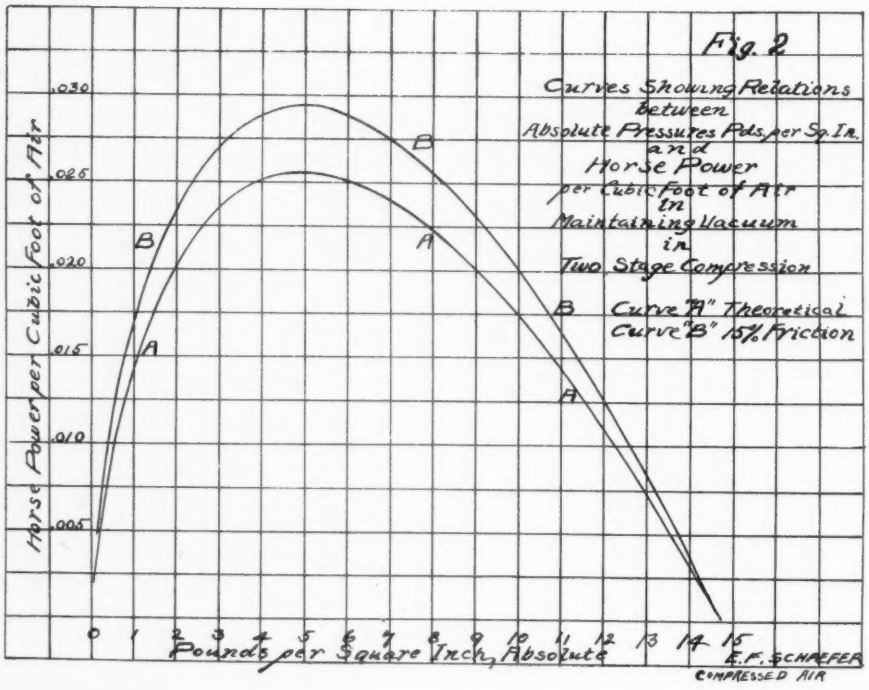
Fig. 2
Curves Showing Relations between Absolute Pressures Pds. per Sq. In. and Horse Power per Cubic Foot of Air in Maintaining Vacuum in Two Stage Compression
B Curve "A" Theoretical
Curve "B" 15% Friction
Horse Power per Cubic Foot of Air
.030
.025
.020
.015
.010
.005
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Pounds per Square Inch, Absolute
A
B
E.F. SCHAEFER
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imum points, equations (2) and (3) were differentiated. The first differential coefficients of the M. E. Ps as functions of the vacuum pressures were then made equal to zero and the equations solved for P_v. In the case of single stage compression $P_v = 4.521$, and for two stage $P_v = 5.004$.

The expressions were then differentiated a second time to secure the second differential coefficients of the M. E. Ps as functions of P_v. In each case the result was a negative quantity, proving 4.521 and 5.004 to be maximum values.

For simple compression we have in detail

$$\text{M. E. P.} = 3.45\, P_v \left[\left(\frac{P_a}{P_v}\right)^{0.29} - 1\right]$$

$$= 3.45\, P_v \frac{(P_a)^{0.29}}{(P_v)^{0.29}} - 3.45\, P_v$$

$$= 3.45 \left(P_v\right)^{1-0.29} \left(P_a\right)^{0.29} - 3.45\, P_v$$

$$= 3.45 \left(P_v\right)^{0.71} \left(P_a\right)^{0.29} - 3.45\, P_v$$

Differentiate

$$d(\text{M. E. P.}) = 3.45 \left(P_a\right)^{0.29} d\left(P_v\right)^{0.71} - 3.45\, dP_v$$

$$\frac{d(\text{M. E. P.})}{d\,P_v} = 3.45 \left(P_a\right)^{0.29} \times 0.71 \left(P_v\right)^{0.71-1} - 3.45 = 0 \quad (4)$$

$$\therefore \left(P_a\right)^{0.29} \times 0.71 \left(P_v\right)^{0.71-1} = 1$$

$$\left(P_v\right)^{-0.29} = \frac{1}{0.71\, P_a^{0.29}} = \frac{1}{1.549}$$

$$\left(P_v\right)^{0.29} = 1.549$$

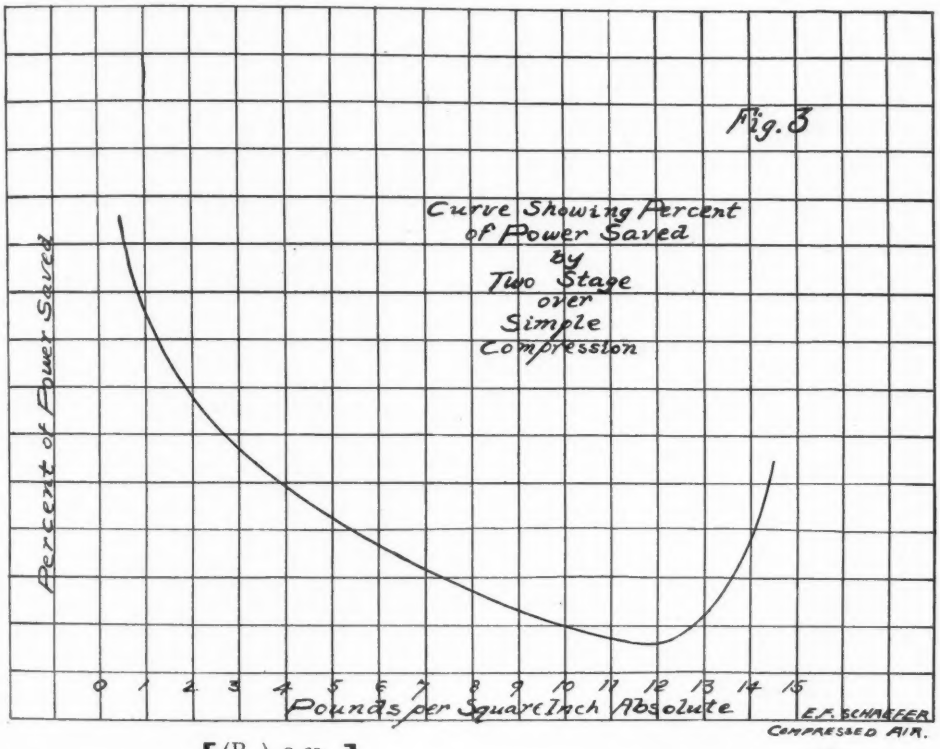


Fig. 3
Curve Showing Percent of Power Saved by Two Stage over Simple Compression
Percent of Power Saved
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Pounds per Square Inch Absolute
E.F. SCHAEFER
COMPRESSED AIR.

$$\left(P_v\right) = \left(1.549\right)^{\frac{1}{0.29}}$$

$$P_v = 4.521 \quad \ldots\ldots\ldots\ldots (5)$$

Differentiate (4) a second time.

$$\frac{d^2(\text{M. E. P.})}{d\,P_v^{\,2}} = 3.45 \left(P_a\right)^{0.29} \times 0.71 (0.71-1) \left(P_v\right)^{0.71-2}$$

$$= -2.$$

which is an even order and negative showing that $P_v = 4.521$ corresponds to a maximum.

The same solution was applied to equation (3) for two stage compression and it was

found that when $P_v = 5.004$ the value was a maximum.

For the vacuum pressure 4.521 pounds the M. E. P. for single stage compression is 6.379 pounds per square inch, giving as the theoretical developed horse-power per cubic foot of air 0.02781. For this same pressure the horse-power for two stage compression is 0.02543. The percentage of power then saved by two stage over simple compression, for this case, is expressed by $(0.02781 - 0.02543) \div 0.02781$ or 8.6%.

It will be seen that in the tabulated list an

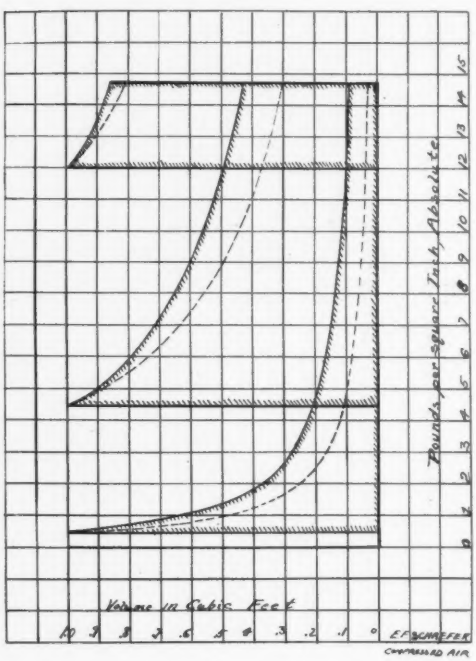


FIG. 4.

additional item is found for both single and two stage compression. It reads "Developed horse-power 15% friction included." The figures under this head are what are used in actual calculations, since in them are included the various frictions due to the piston, cross-head, crank-pin, etc.

The compressor cylinders when employed for purposes of producing vacuum are seldom water-jacketed. A jacket is hardly necessary since the air which is compressed, although it has the same temperature range as when compressed under corresponding ranges above the atmosphere, has less *capacity* for heat due to its rarified condition.

This lack of heat capacity of air under pressure below normal obviates the use, in most instances, of intercoolers for two stage compression. The results in the table were secured by assuming that an intercooler was employed and that the air entered the high pressure cylinders at 60° Fahrenheit. Using the intercooler when operating under a vacuum of 28.94 inches of mercury will effect a saving of 23.9% in power.

Of course in cases where the intercooler is dispensed with the horse-powers for single and for two stage compression are identical. The advantage of compounding without using the intercooler is to reduce the losses due to clearance.

HORSE-POWER DEVELOPED

in adiabatically compressing and in discharging one cubic foot of air from various degrees of vacuum into the atmosphere (14.75 # □″).

Initial temperature of air in each cylinder taken as 60° Fahrenheit.

Jacket cooling not considered.

E. F. SCHAEFER.

VACUUM.		ONE-STAGE COMPRESSION.			TWO-STAGE COMPRESSION.			
Absolute pressure. Pds. per sq. in.	Inches Mercury.	M. E. P. per sq. in. (Theoretical)	Developed H. P. (Theoretical)	Developed H. P. 15% friction included.	M. E. P. per sq. in. (Theoretical)	Developed H. P. (Theoretical)	Developed H. P. 15% friction included.	Per cent. of power saved by two-stage over one-stage comp. (Theoret'c'l)
0	29.90	0.000	.00000	.00000	0.000	.00000	.00000	—
0.5	28.94	2.877	.01254	.01442	2.187	.00954	01097	23.9
1	27.88	4.081	.01779	.02046	3.291	.01435	.01651	19.3
2	25.85	5.417	.02362	.02716	4.637	.02022	.02325	14.4
3	23.81	6.075	.02649	03046	5.361	.02337	.02688	11.7
4	21.77	6.348	.02768	.03183	5.741	02503	.02878	9.6
4.521	20.80	6.379	.02781	.03198	5.833	.02543	.02924	8.6
5	19 74	6.348	.02768	.03183	5.865	.02557	.02941	7.6
5.004	19.70	6 353	.02770	.03186	5.870	.02559	.02943	7.6
6	17.70	6.169	02690	.03094	5.755	.02509	.02885	6.7
7	15.66	5.820	.02538	.02919	5.506	.02401	.02761	5.4
8	13.63	5.354	.02334	02684	5.134	.02238	.02574	4.1
9	11.59	4.782	.02085	.02398	4.595	.02003	.02304	3.7
10	9.55	4.106	.01790	.02059	4.002	.01745	02007	2.5
11	7.51	3.378	.01473	.01694	3.317	.01446	.01663	1.8
12	5.48	2.525	.01101	.01266	2.484	.01083	.01246	1.6
13	3.44	1.659	.00723	.00832	1.614	.00704	.00810	2.7
14	1.40	0.725	.00316	.00363	0.676	.00295	.00339	6.7
14.75	0.00	0.000	.00000	.00000	0.000	.00000	00000	—

Fig. 1 shows the relations between various degrees of vacuum and the horse-powers necessary to maintain the same when compressing in a *single stage*. Two curves are shown, one giving the theoretical, and the other the actual relations when friction is included.

Fig. 2 is identical with Fig. 1, except that it is constructed for *two stage* compression when an intercooler is employed. In both Figs.

1 and 2 the points at which the maximum values fall are clearly defined.

Fig. 3 gives the variations in per cent. of power saved by two stage over simple compression for various vacuums. It will be noted that minimum saving in power is effected when maintaining a vacuum of 12 pounds or 5.48 inches mercury. (The calculus is necessary for determining the exact point but 12 pounds is sufficiently close for all purposes.)

VOLUMES IN CUBIC FEET

when compressing one cubic foot of air from various degrees of vacuum to various absolute pressures. E. F. SCHAEFER.

ABSOLUTE PRESSURES. Pounds per square inch.		VOLUMES. Cubic Feet.	
		Isothermal.	Adiabatic.
P_1	P_2	$(P_1 \div P_2)$	$(P_1 \div P_2)^{0.71}$
0.5	14.75	.0339	.0905
0.5	10.00	.0500	.1192
0.5	8.00	.0625	.1397
0.5	6.00	.0832	.1711
0.5	4.00	.1250	.2285
0.5	2.00	.2500	.3737
4.521	14.75	.307	.4324
4.521	12.00	.377	.5003
4.521	10.00	.452	.5691
4.521	8.00	.565	.6667
4.521	6.00	.753	.8160
4.521	5.00	.904	.9310
12.000	14.75	.813	.8633
12.000	14.00	.857	.8962
12.000	13.00	.923	.9447
12.000	12.50	.960	.9715

Fig. 4 consists of three indicator cards gotten when compressing adiabatically from 0.5, 4.521 and 12 pounds absolute to atmospheric pressure. The isothermal compression curves are also indicated by dotted lines. These cards show more clearly, perhaps, than our horse-power curves just *why* it takes less power to compress from pressures either side of 4.521 pounds. A planimeter might advantageously be brought into play and it will be found that the areas are in the same ratios as the M. E. Ps.

In plotting these cards the fundamental formula for adiabatic compression was employed.

$$P_1 V_1^n = P_2 V_2^n$$

V_1 = unity therefore V_1^n = unity

$n = 1.41$

$$\text{therfore } V_2 = \frac{P_1}{P_2}$$

$$\text{or } V_2 = \left(\frac{P_1}{P_2}\right)^{\frac{1}{n}} = \left(\frac{P_1}{P_2}\right)^{0.71}$$

For isothermal compression

$$V_2 = \frac{P_1}{P_2}$$

A saving in power is a saving in coal and this is a saving in money. In operating vacuum pumps it must be evident from what has been said that it is highly advantageous *not* to maintain a pressure near 4.521 pounds per square inch absolute. By keeping away from this maximum energy point, economy is effected.

A NEW ASHPIT.

Written for COMPRESSED AIR.

One of the most important features in connection with the despatching of locomotives at roundhouses is the Ashpit over which the fire is cleaned, and into which the ashes are dumped. Also the means for removing the ashes from the pit, and loading them on to cars.

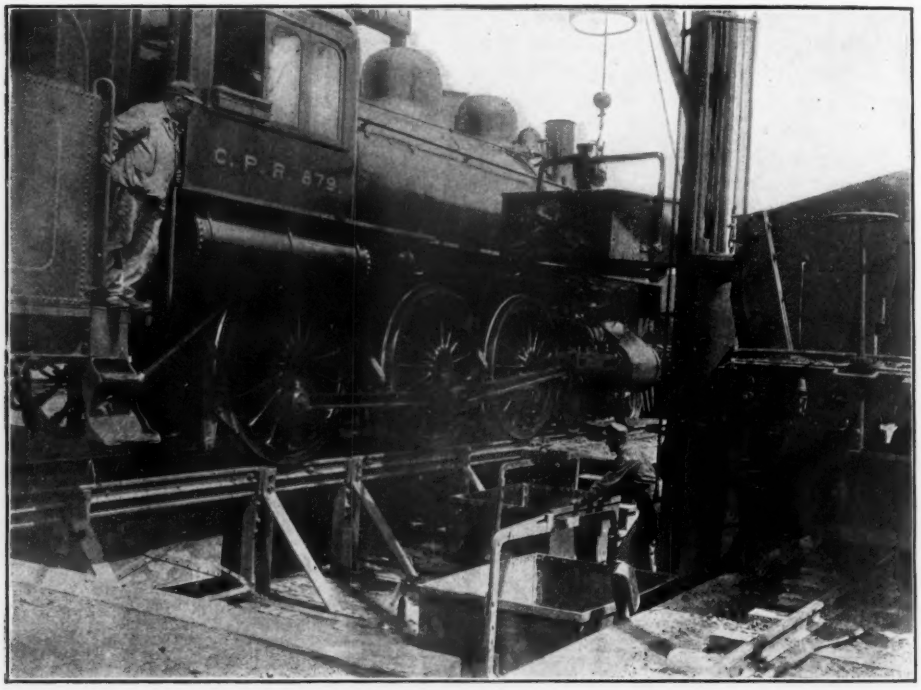
The first form of ashpit for this purpose was constructed with its sides immediately under the rails of the track, upon which the locomotive would come on to the turntable, and thence to the roundhouse. The track is usually called the "incoming" track.

These pits were of different lengths, according to the number of engines arriving per day. They would be of sufficient depth so that a man could stand in them and conveniently work a hoe or scraper at either end of the ashpan and draw the ashes out, allowing them to fall into the pit. The locomotive would then be moved off the pit into the roundhouse, and the ashes would be shovelled out of the pit on to the surface of the ground, and while this was being done another engine could not come over that portion of pit, but, if the pit was long enough, it could have its fire cleaned at another point on same. If, however, it was not long enough for this, it would have to wait until the ashes in the pit were thrown out, or else have its ashes dumped in the same place, which would soon result in the pit becoming full of ashes, so that it would be absolutely necessary for the engines to be kept off the pit until the ashes were thrown out. It was therefore better, after each engine had had its fire cleaned, to throw out the ashes, no mat-

ter whether the pit was long or short. This was not only expensive in the handling of ashes, but often caused delay to power.

The ashes now at the side of the pit had to be thrown on to the cars, and if the pit was long there would require to be a sufficient number of ash cars to correspond to the length of the pit, so that the ashes thrown out of the pit at any point could be thrown on to a car.

In some cases buckets have been placed in the pit to receive the ashes direct from the pan, and when the engine was moved off the pit, the buckets would be hoisted and dumped on to the ash car and the bucket returned again to the pit, but until the buckets were replaced, another engine could not come on to the pit. This therefore was objectionable on account of delay to the engines.



VIEW NO. I.

If the switching out of cars, when loaded, and placing of empty cars was not regularly attended to, a pile of ashes would collect at the side of the pit, and in winter time would freeze, on account of having been wetted as they were drawn out of the pan, to prevent the dust from getting on the engine. The removal of the frozen pile would cost still more, and in summer, if hostlers were not very careful, the steam from the cylinder cocks would blow the ashes over the engine.

The only satisfactory way therefore of doing this work was not to allow the ashes to accumulate in the pit or at the side of the pit.

To overcome the difficulties above outlined different improvements have been introduced.

Other arrangements have been introduced where a bucket on wheels would run down rails on an inclined plane, entering the pit from the side by going underneath the rail. This form would not keep the engine waiting, while the bucket was being drawn out when full, but it worked from one end of the ashpan only, and a second apparatus of the same type would be needed to dispose of the ashes at the other end of the ashpan.

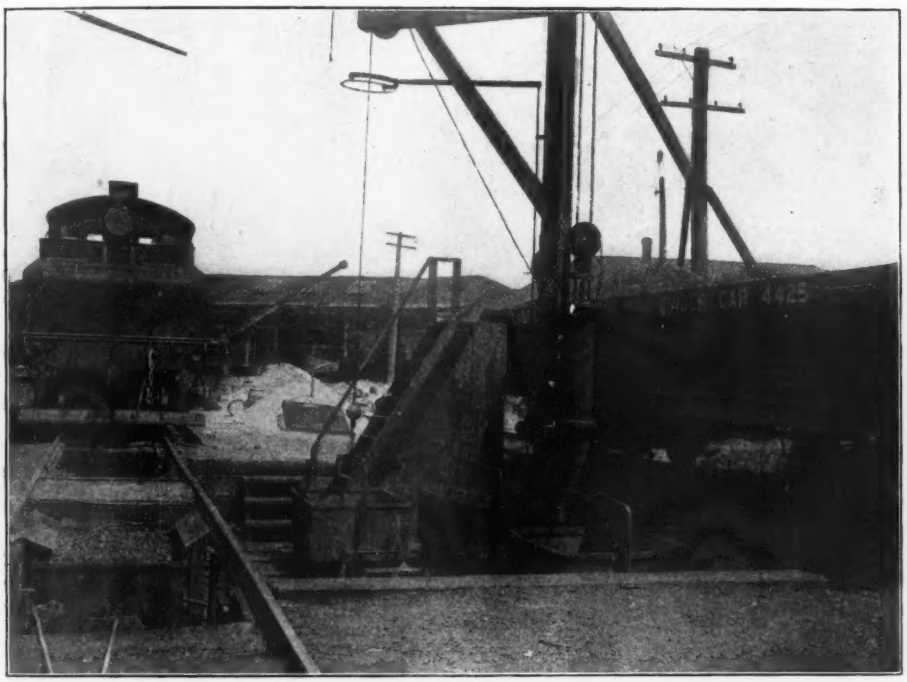
It further would dump the ashes on the car at the same point as each following bucketful was drawn up and the car would need constant shifting. The arrangement was further objectionable as the rails upon which the bucket ran upward extended over the ashcar

track, preventing a high car or an engine coming on this track.

There is another form of ashpit, known as the "Open Side Ashpit," with depressed ashcar track. This pit has the rail on one side, supported on columns or standards, and the ashes can be shovelled out from the side; the man doing the work of shovelling stands at the side of the pit on the same level as bottom of pit, and in order that he will not have too high a throw for the ashes, the ashcar track is depressed, the rails being about on a level with the bottom of the ashpit. With one shovelling, therefore, the ashes are thrown from the bottom of the ashpit onto the car.

With this kind of pit there need be no delay to engines, but it is expensive, as in the first place the ashes are all loaded by hand, and, where many engines are coming in, the pit must be long, and there would require to be sufficient cars to cover its full length, also a laborer cannot throw ashes over a high-sided car and heap them up, consequently more cars are needed. Watering facilities are also needed to cover the length of a long pit of this description, so the ashes can be wetted at whatever point the engine may be stopped. These arrangements if not properly protected will freeze, and a free use of water washes the ashes into the drain, floods the depressed track and covers it with ice.

It must also be remembered that where the first engine comes on a long pit, it is placed at the end nearest the turntable; other engines follow and take positions on the pit, and the work of fire cleaning is begun as each engine is placed. When the first and second have had the fire cleaned the third may only have its fire half done. This prevents that portion of the pit which was occupied by the first and second engine being used until the third has had its fire cleaned and is moved off the pit.



VIEW NO. 2.

The accompanying photographs give different views of an ashpit which was designed and patented by C. R. Ord, Master Mechanic of the Atlantic Division of the Canadian Pacific Railway, and it is claimed by the inventor that all the objections above mentioned have been overcome in this device.

View No. 1. Loaded bucket can be seen par-

tially hoisted over further track in pit, and man in pit pushing spare empty bucket into position under ashpan, formerly occupied by bucket now being hoisted with load of ashes to be dumped into car.

View No. 2. View of ashpit with locomotive standing beyond. One loaded bucket has been drawn from under the rails and is about to be hoisted by crane, cable being coupled to same. The other loaded bucket can be seen between the rails, with aprons which are secured to each rail, preventing the ashes from falling outside of buckets as they are raked out of ashpan. The spare empty bucket is now standing at the outer part of pit. The guides for directing the buckets onto the rails after they have been emptied can also be seen in this view.

View No. 3. A view of ashpit with one bucket hoisted and swung directly over ashcar, man standing at crane with right hand on lever, by which the crane is swung, and left hand on lever of dumping apparatus by which the latch of bucket is thrown out and bucket allowed to turn over and dump ashes.

View No. 4. View of ashpit with crane, showing the steel cable of crane connected to a heavy manilla rope, later passing around pulley which is secured to further side of ashpit, the other end of rope to which a hook has been spliced, connected to ashcar, the car being drawn into position by means of crane, doing away with the necessity of switch engine to shift cars in order that they may be fully loaded. This crane moves six cars in this manner.

From these views it can be seen that the locomotives can be moved on and off the pit without in any way interfering with the removal of ashes as the loaded buckets are drawn out under the rail, and while the loaded bucket is being hoisted, if need be, the empty one can immeiately be pushed under to receive any remaining ashes, or to be ready for another engine. There are four buckets in the pit, two for each end of ashpan. They hold 1,500 pounds of ashes, and have smokebox setting in the bottom to let the water run out, but prevent large cinders from blocking the drain.

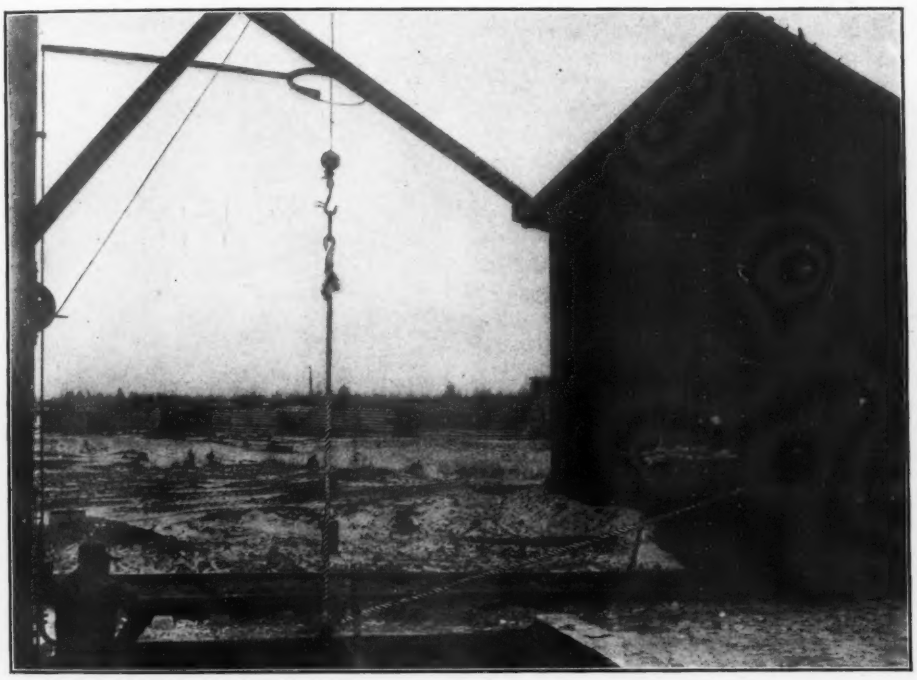
The tracks upon which the buckets move are made of common iron piping, and steam passes

through them in cold weather, keeping the oil from freezing on wheels of buckets, and also keeping the pit free of snow and ice in the winter time.

At each end of the pit extra openings can be seen under the rails for the men to get under the engine and rake the ashes from each end of the ashpit and avoid the danger of crawling between the wheels. When the men are in position at each end of the pan the buckets stand immediately in front of them, and the ash hoes are kept at each end of the pit, between rails, and can be drawn forward when needed. There is also a very convenient arrangement for each man for wetting the ashes. A pair of pipes come through the side of the pit at each end, one for steam and the other for water. Valves are placed just clear of pit wall, and beyond the valves the two pipes are joined in one, to which a length of hose is attached. When not in use in cold weather the water valve is shut and a slight escape of steam keeps the hose from freezing. Water can be used for wetting the ashes, or steam for thawing frozen ashpans.

With the crane for hoisting the buckets a very heavy load of ashes can be put on the car to any desired height. The dumpings can be distributed over the car and one shift only is needed to fill it from end to end. The next car can be then drawn into position by crane, as shown in view No. 4.

Two of these pits have been in operation, one at McAdam, N. B., and the other at Brownville, Me., for over two years, and have given perfect satisfaction during two of the hardest winters experienced for many years. The cost of labor of loading ashes on the cars has been one cent per ton. Average time taken to draw buckets from under engine, dump ashes on car and replace under engine is three minutes. In ordinary business one man on each shift has hoisted the ashes, hoed out one end of ashpan, placed the ashcars and dried the sand.



VIEW NO. 4.

With the crews handling incoming engines about fifty engines can be handled per day on this pit. An engine is put on the pit, fire cleaned and put in the house. The following engine is put on the pit by second crew. The first crew returning from engine-house take charge of third engine, which they coal, sand and water, and by this time the second engine has the fire cleaned and is ready to move on turntable.

The pit is 36 feet long between the rails to give room to work the hoe. Outside of rails it measures 27 feet, and is therefore bridged by one rail. The width from rail to ashcar track is 15 feet.

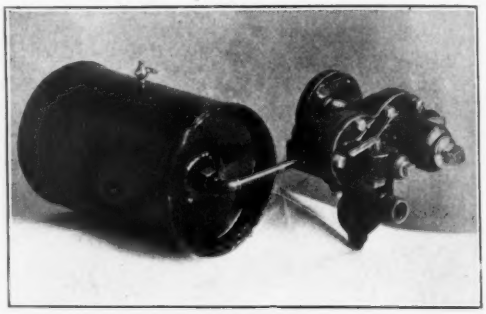
The ash buckets are 5 feet long, and are so situated as to suit engines with long or short ashpans. They are operated by compressed air.

AN IMPROVED TRIPLE VALVE.

Written for COMPRESSED AIR.

A new triple valve has just been invented by Oliver L. Goodnight, member of the Air Brake Association, to overcome the disadvantages of the present system of air brake control. After large locomotives were introduced upon modern railways, for hauling long trains, it became apparent to trainmen that the air brake was not yet perfect, as, in the case of a long train running at a slow rate of speed and making release without stopping, release would begin at the head car and continue serially, thus ending upon the rear car and causing the slack to run ahead from the rear end with such sudden force that in many cases danger resulted to the train rigging, and draw boards, and delays to traffic were frequent on account of the breaking apart of the train. The new valve is designed to overcome these difficulties.

The illustration shows the exterion appearance of this apparatus with controlling valve placed at a right angle. Constant pressure, equal to the normal brake pipe pressure, is maintained in the drum, and also against the release piston on opposite side of brake pipe. This permits the engineer to apply brakes and re-charge to normal brake pipe pressure by moving the brake valve handle from lap to running position, thereby forcing the guiding piston to assume position of release. With the head brakes in this position, which is high pressure release, and the small valve handle placed as shown in the illustration, in a straight line position on the rear brakes, which is low pressure release position, the rear half of the train, or any portion that may be determined, will be released in advance of the head brakes, while at the same time the entire train may be re-charged, and the slack allowed to bunch forward in readiness for releasing head brakes, by moving the brake valve handle to full release position; or, should it be desired to make a quicker and more sure release following the usual application, the brake valve handle may be moved from lap to full release position, then immediately back to lap position; the main receiver pressure will then back through the brake pipe, forcing all triple valves to assume a release position; and, on account of brake valve handle being placed again at lap position, the pressure will immediately drop below normal in the brake pipe; this is due to feeding through the feeding grooves into the auxiliary receivers and allowing the pressure in the small drum to force the release position immediately back on lap position and close the inside ports of the triple valves. Thus a portion of the brake cylinder pressure will be held and the brakes remain applied



EXTERIOR VIEW OF NEW TRIPLE VALVE.

with reduced brake cylinder pressure. At the same time the rear brakes will be fully released.

Retaining valves on cars are disposed with entirely and the engineer is given full control of the brakes upon a train at all times, without depending upon trainmen to operate the retaining valves. It is claimed that this brake can be applied and released from the engine just as easily as any other brake with triple valves regulated in either position. Furthermore, the apparatus has all the advantages of being standard and interchangeable with present air brake systems. The important features may also be attached to the present triple valve on a car without necessitating any changes. The device is patented in the United States and foreign countries with further patents pending.

THE EDUCATION OF MINING EGINEERS.

BY J. W. GREGORY.*

The fundamental difficulty in mining education is the fact that the mining engineer requires a training which must be both unusually wide and thorough. The miner's knowledge must be exceptionally varied, for he often has to work in remote localities, where he must be self-reliant; at the same time his work requires a high standard of attainment. He needs to be well versed in many branches of civil, mechanical, and electrical engineering, and, at the same time, his knowledge of chemistry, geology, and mineralogy must be sufficiently sound to be practically useful. The mining engineer, in fact, must have the most of the training of an ordinary engineer, for he may be called on to lay down railways, build bridges, erect large workshops and furnaces, construct dredges and dig vast excavations. And in addition to these qualifications he must have his special mining education as well. This burden is, however, not unfairly heavy, for the rewards of the successful mining engineer are great.

The first serious fault in the existing schemes of British mining education seems their failure to recognize this essential requirement, as shown by the inadequate length of the courses. The American and Australian universities insist upon a course of four or five years.

The answers to the inquiries of the committee of the Institute of Civil Enigneers (London) show that in Great Britain the length of course favored for a civil engineer is three years at a university or technical college and four years in practical training in workshops. If this seven years' course be necessary for a civil or mechanical engineer, it seems impossible to train a competent mining engineer in two years of theoretical and one year of practical work. The mining engineer should have the three years' theoretical training, like the civil engineer, and at least one year extra for his special work. And granting a college course of that length, then two or three years of practical work would, in the majority of cases, probably be adequate. One year's work in the machine shop of a large colliery would be the best preliminary practical course available for British students, and then three or four long vacations, each of not less than four or five months, spent in mines, should supply the necessary amount and variety of practical training.

The proportion of time spent in practical training may be less in mining than in mechanical engineering, but the use made of a spell of practical work should be more closely watched, to avoid the deplorable waste of time that often occurs in it. Many a student puts in a period of "practical work" which consists only of such jobs as trucking. Time thus spent is wasted to a mining engineer as it would be to a lawyer if his first year in articles were spent in cleaning office windows or polishing the brass-plate on the front door.

It is said that there is no chance in this country (Great Britain) of students of mining engineering undertaking so long a course of study as is required for medical qualifications. If it be the case that the British mining course is to be limited to two or three years, then it seems to me hopeless to expect British mining education to reach really front rank. The American institutions have often great wealth, which is, moreover, less mortgaged to subjects of secondary value; and their constitutions are more elastic. There seems little chance of our less free educational institutions reaching, in a two years' course, the level for which more advantageously placed American universities are willing to give five years.

The educational committee of the Institution of Civil Engineers complains that "at present a considerable proportion of students enter technical institutions ill-prepared, and at least one year has to be devoted to instruction which ought to be secured beforehand."

The main drawback of the long academic year is that it is fatal to the "sandwich system," by which students can spend six or seven months at a university and the other five or six months in practical work. There are obvious objections to this course. The most serious is that the expensive teaching equipment has long intervals of idleness, except in so far as it may be used for research work and by honors' students during special summer courses. In technical subjects, however, the advantages of the "sandwich system" seem to me far to outweigh the drawbacks. Employers complain that the students of some of our best universities and colleges come from them

* Abstract of paper read recently before the Istitution of Mining Engineers, London.

with an academic spirit, which spoils the men for years and sometimes hampers them for life. The writer remembers being surprised, on trying to persuade a chemical manufacturer to give an appointment to a student from what he considered probably our most efficient technical college, to hear the men previously engaged from it had proved useless owing to their impracticability. The knowledge of the men was admittedly sound, but it was said that they could not apply it, owing to lack of common sense and practical insight. The spirit of a university and a college is remarkably different from that of the business world, and success in the complex profession of mining requires commercial instincts as well as technical knowledge. It seems to the writer most important that students who intend to adopt a technical profession should not be kept for some years continuously in a college atmosphere. The contact for six months in the year with the practical work of the world gives the necessary corrective, and is invaluable educational training.

Manufacturers and mine managers do not care to engage students who cannot stay more than from four to six months. The "sandwich system" is most practicable for schools which are situated on or near mining fields, or in which the staff are personally well acquainted, perhaps by consulting practice, with mining authorities. Schools, on the other hand, which are separated from mining, geographically or personally, will generally tend to prefer that the course of study should run continuously, and that the practical training should be gained either before or after the college course.

The "sandwich system" is economical of the students' time, for it enables them, by the change from college study to manual exercise, to work throughout the year without risk of injury to health, or of becoming stale. Accordingly, in three years a student can put in 34½ or 35 months' work, whereas with a college session of nine months, the vacations are too short to be of practical use, and the three years give only 27 working months.

The "sandwich system," moreover, renders it much easier to equip schools economically, for if the students see the current methods in actual use, and mining operations and metallurgical equipment on a large scale, there is less need for burdening our laboratories with full-sized mining plants.

The drawbacks of a full-sized equipment are that it is soon out of date, and then is most expensive to renew; while it is such a glutton for material that its running is a heavy drain on the revenue of a department. Some schools recoup the expense of using such machinery by treating ore commercially. But in such cases the tendency is for the plant to be handled by trained mechanics, and the students are not allowed to take much share in the actual work, for the mistakes, which are all important educationally to the student, cannot be allowed to occur. Such commercial practice in a college seems to me usually unsatisfactory, with some obvious exceptions.

There is a general agreement as to the main outline of the course of instruction required by the mining engineer, and the differences in detail are largely due to the varying local opportunities and requirements. Coal miners need most mechanical engineering, including ventilation, and metal miners most geology, while copper miners, in addition to geology, need ample metallurgy.

The amount of geological teaching in this country in mining seems to me very inadequate, and America has led the way in a fuller recognition of the needs of geology in mining. The Royal School of Mines adopts the excellent method of taking one subject at a time, working at it all day and every day till the amount of time devoted to the subject is exhausted. This system of continuous running has many recommendations, and it is found to answer by many educational coaches who are experts in teaching against time. But at the Royal School of Mines the higher course in geology is apparently not required for the associateship either in mining or in metallurgy.

A FRENCH engineer has constructed an experimental internal continuous combustion turbine, with the combustion chamber lined with refractory material. Gasolene is fed through a nozzle from a compressor on the turbine shaft and mixed with air, electric lignition being used. The resultant temperature is 1,800 deg. C. (3,272 deg. F.). The gas given off impinges upon the turbine blades, which are kept cool by low pressure steam being generated in water jackets around the gas nozzle. This turbine is said to have shown an efficiency of 18 per cent., and improvements now being made in the compressor are expected to bring this figure above 25 per cent.—*Exchange.*

ON THE MEASUREMENT OF AIR FLOWING INTO THE ATMOSPHERE THROUGH CIRCULAR ORIFICES IN THIN PLATES AND UNDER SMALL DIFFERENCES OF PRESSURE.

By R. J. Durley, Montreal Canada.

(Concluded from the September issue.)

29. The method used in making the trials was as follows:—The reservoir was pumped up and the valve between it and the compressor was then closed. Sufficient time was allowed for the air in the reservoir to come to a uniform temperature. The gate valve V, being open, the regulating valve V_2 was opened till the head of air in the box was brought to the point at which the trial was to be run. The gate valve was then closed and the chronograph switch thrown in so that when the valve was reopened a record of the time would be made. The initial pressure and temperature in the reservoir were then read and the trial started. The final temperature and pressure were not read immediately at the end of the trial as it was found that some time elapsed before the air in the reservoir had resumed a uniform temperature. The leak during this time was allowed for, but was very small since the pressure in the reservoir was low.

Accuracy of Results.

30. Upon consideration it was found that the effect of the errors shown in Table I upon the final result might cause a total possible error of about ± 7 per cent. on the 5-16 inch orifice at 1 inch head, or of about $\pm 1\frac{1}{2}$ per cent. in the case of the 4 inch orifice at 4 inch head. The actual deviations of the observed results from the mean curves were found to be within these limits when allowance was made for the effect of the size of the gauging box on the results, as explained below.

31. The probable errors have been calculated for the various series of experiments made at different heads, and are,—

Head.	Probable error %
1 inch.	0.735
2 "	0.470
3 "	0.635
4 "	0.667
5 "	0.650

It seems permissible therefore to regard the figures ot Tables IV and V as being reliable to within less than 1 per cent.

Corrections for Barometric Pressure and Temperature.

32. From equation (3) it is seen that when the difference of pressure on the two sides of an orifice is small, the weight of air discharged per second should vary directly as the square root of the mean pressure and inversely as the square root of the absolute temperature. In tabulating the results of the experiments made it was therefore necessary to reduce all the actual discharges, as measured, to their values at 60 degrees Fahr., and 30 inches barometric pressure. A special series of trials (Nos. 151-162) was made to see whether the actual discharge would vary as above with regard to temperature. For this purpose the air was passed through the heater (H, Fig. 2) previously described, and was delivered to an orifice one inch diameter under a head of 3 inches of water, at a series of successively increasing temperatures. It was found during each experiment that the temperature in the gauging box could be kept constant within 1 degree Fahr., and the trials were made between the limits 55 degrees and 105 degrees Fahr. After measuring the actual discharge in each case, and correcting for barometric pressure, the mean line (Fig. 4) was drawn—and the corrected discharges tabulated from it. The figures for these trials are given in Table II, and show that within the limits of these experiments the discharge may be taken to vary inversely as the square root of the absolute temperature in the gauging box.

33. It was found impossible to make the numerous joints of the heater perfectly air tight. The air leaking out was, of course, visible in the water in the containing tank, its greatest amount was found to be about 0.000037 pounds per second and was allowed for in calculation, being measured by displacement in each case. The heater was not employed for the other trials and in them this source of error did not exist.

Calculation of Actual Discharge from Experiments.

34. Trials 1-146 were made with the temparature in the box as near 60 degrees Fahr. as possible, and variations from this temperature were allowed for, as mentioned above, on the

assumption that the discharge is inversely proportional to the square root of the absolute temperature. Proper correction for barometric pressure was also applied, and from these experiments the actual discharge was then calculated. The corresponding ideal discharge was also worked out from equation (4) for a temperature of 60 degrees and a pressure of 30 inches of mercury. The actual discharge per square foot of orifice was then computed for each experiment and the results plotted on Fig. (5). In Figs. (6) and (6a) are shown the values of the coefficient of discharge obtained from the curves of figure (5), and from the corresponding ideal discharges.

35. The volume of the reservoirs and attached piping being 91.881 cubic feet, it is readily shown that the weight actually discharged per second (if the pressure in the reservoirs changed from P_1 to P_2 pounds per square inch, and the temperature from T to T degrees Fahr., absolute, in t seconds), is given by—

$$W = \frac{248.3}{t}\left(\frac{P_1}{T_1} - \frac{P_2}{T_2}\right) \quad . \quad . \quad (5)$$

The actual discharge was in every case calculated by this formula from the observed quantities, corrections being applied as explained above.

36. With each orifice five sets of experiments were made at heads of from 1 inch to 5 inch of water. Figure eight shows for one orifice the corrected actual discharge and mean curve plotted on a base of difference of pressure. The mean curve was, of course, found by using the coëfficients of discharge of Figs. (6) and (6a).

37. Fig. (6) shows the curves of coefficients of discharge for various diameters of orifice plotted on a base of difference of pressure at orifice. From this diagram and from Figure (6a) can be selected a suitable coefficient for use in any particular case. The detailed results of the various trials are given in Tables VI to XVI.

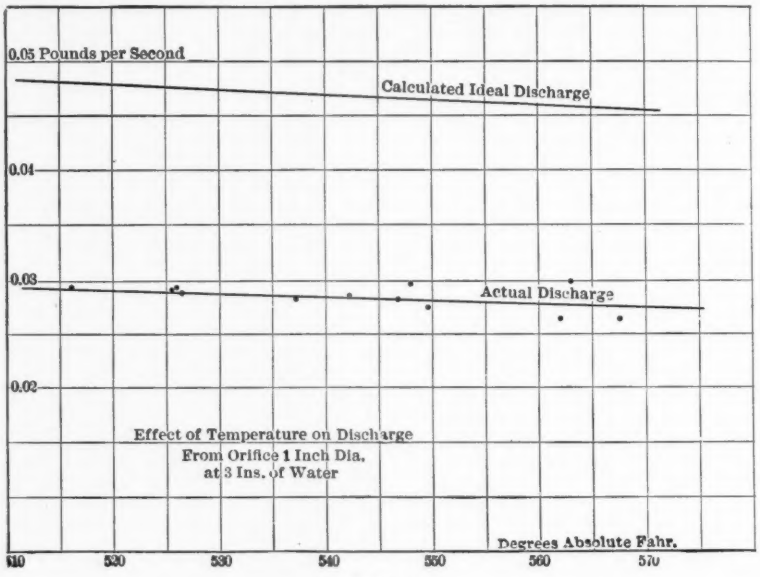


FIG. 4.

Effect of Size of Gauging Box.

38. From the curves of Fig. (5), it was seen that the actual discharges of the larger orifices at the higher heads were considerably above the mean curve. This seemed to indicate that the results were being effected by the velocity of approach of the air. To check this, experiments (147–150 inclusive) were made with a 3 inch orifice at 1 inch and 5 inch heads, using a box whose area was only 13.8 times that of the orifice. The results of these trials were compared with those obtained from the same orifice in the large box and it was found that the discharge was 0.2 per cent. higher at the 1 inch head and 10 per cent. higher at the 5 inch head. This variation was greater than that observed from the trials of the 4½ inch orifice in the large box, the difference being due

to the smaller ratio between the areas of box and orifice. The curve of observed discharge from the 3 inch orifice in the large box, even at the highest heads experimented with, lies only very slightly above the curve of corrected discharge. These results show that the area of cross section of the gauging box should, for heads up to 5 inches, be at least twenty times the area of the orifice if reasonably accurate results are to be obtained. For greater heads a still larger box would probably be necessary.

Conclusions and Remarks.

39. The experiments and curves indicate that:—

(1) The coefficient for small orifices increases as the head increases, but at a lesser rate the larger the orifices, till for the 2 inch orifice it is almost constant. For orifices larger than 2 inches it decreases as the head increases, and at a greater rate the larger the orifice.

(2) The coefficient decreases as the diameter of the orifice increases and at a greater rate the higher the head.

(3) The coefficient does not change appreciably with temperature (between 40 degrees and 100 degrees Fahr.).

(4) The coefficient (at heads under 6 inches) is not appreciably affected by the size of the box if the ratio of the areas of the box and orifice is at least 20:1.

40. It is hoped that the information given in this paper will enable a reasonably accurate measurement of air at low pressure to be made by the use of a comparatively simple and inexpensive gauging apparatus.

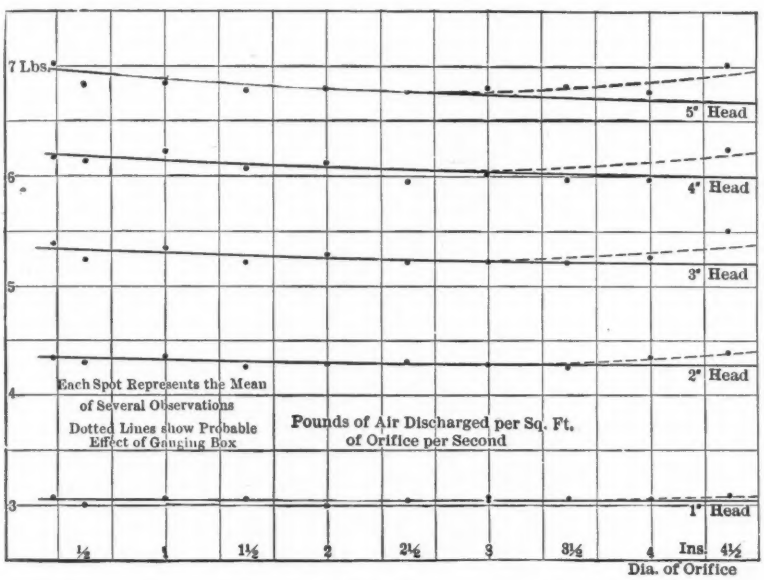


FIG. 5.

NOTE.—On derivation of equation (1).

Let W = weight of gas discharged per second in pounds.

A = area of cross section of jet in square feet.

P_1, P_2 = pressures inside and outside orifice in pounds per square foot.

V_1, V_2 = corresponding specific volumes.

y = ratio of the specific heats K_p / K.

K = Kinetic energy of 1 lb. of gas.

u = velocity of gas at any point.

T = absolute temperature.

If heat is given to a quantity of gas under any circumstances whatever, the amount of heat is equivalent to the increase in internal energy, together with the external work done, and thus, for any small adiabatic change.

$$K_v dT + PdV = 0 \ldots\ldots \ldots\ldots \text{(a)}$$

Again, if there is no friction loss, the amount of heat given to the gas must be equivalent to

the change in Kinetic energy, together with the change in pressure energy (head) together with the change in internal energy, so that for any small adiable change

$$dK + d(PV)\ K_v + dT = 0\ ..\ ....(b)$$

From (a) and (b) we have

$$dK + VdP = 0$$

hence in passing from conditions P_1V_1 to conditions PV we shall have

$$\int_0^u dK = \int_P^{P_1} VdP$$

r, since $PVy =$ constant, and if u is the final velocity,

$$\frac{u_2}{2g} = \frac{y}{y-1}\ (P_1 V_1 - P_2 V_2)$$

$$\text{hence } u = \sqrt{2g\frac{y}{y-1}(P_1 V_1 - P_2 V_2)} =$$

$$\sqrt{2g\frac{y}{y-1}\cdot P_1 V_1\left[1-\left(\frac{P_2}{P_1}\right)^{\frac{y-1}{y}}\right]}$$

and the weight of gas discharged in unit time with frictionless adiabatic flow is

$$W = \frac{Au}{V_2} = A$$

$$\sqrt{2g\frac{y}{y-1}\cdot\frac{P_1}{V_1}\left[\left(\frac{P_2}{P_1}\right)^{\frac{2}{y}} - \left(\frac{P_2}{P_1}\right)^{\frac{y-1}{y}+}\right]}$$

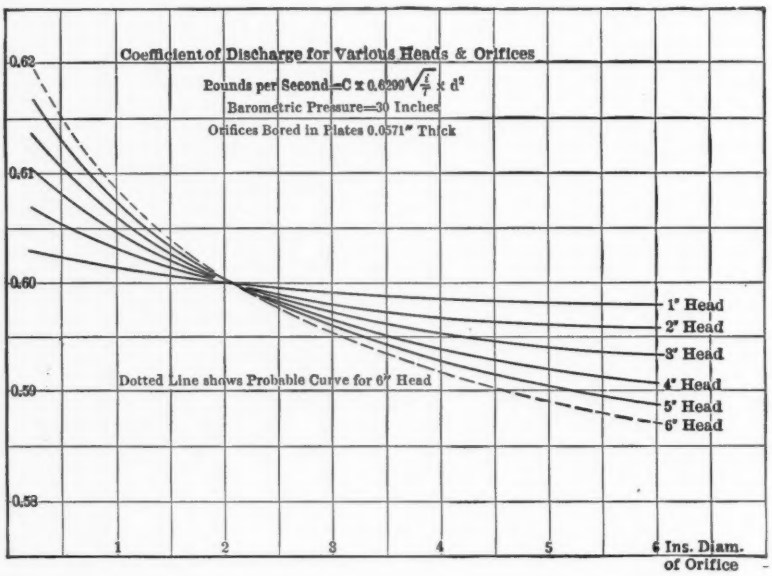


TABLE IX.

No. of trial	Diam. of Orifice ins.	Head ins. water	Duration of trial. Secs.	Reservoir				Box Temp. Abs.	Actual discharge Lbs. Sec.	Corrected actual discharge at 60° F. and 14.7 lbs.
				Abs. Pressure		Abs. Temperature				
				Initial.	Final.	Initial.	Final.			
46	1½	1	572	91.8	44.8	524.1	519.5	519.0	.03870	.03839
47	"	1	592	94.8	44.8	538.3	518.8	519.3	.03772	.03732
48	"	1	586	94.8	44.8	541.3	519.5	519.7	.03773	.03734
49	"	2	417	94.8	44.8	540.8	515.5	518.0	.05274	.05224
50	"	2	600	94.6	26.6	523.4	517.0	513.4	.05368	.05301
51	"	2	600	94.8	26.8	523.2	515.7	514.5	.05318	.05256
52	"	3	373	96.8	44.8	523.7	512.7	516.6	.06500	.06440
53	"	3	319	89.8	44.8	523.4	512.8	516.7	.06570	.06514
54	"	3	339	92.8	44.8	529.4	513.1	516.1	.06459	.06399
55	"	4	286	91.8	44.8	523.8	512.1	516.2	.07632	.07565
56	"	4	306	94.8	44.8	526.9	512.2	514.9	.07518	.07444
57	"	5	273	94.8	44.8	524.7	511.1	517.1	.08480	.08415
58	"	5	267	94.8	44.8	532 0	511.6	515.2	.08445	.08326
59	"	5	256	91.8	44.8	527.7	512.1	514.8	.08401	.08321

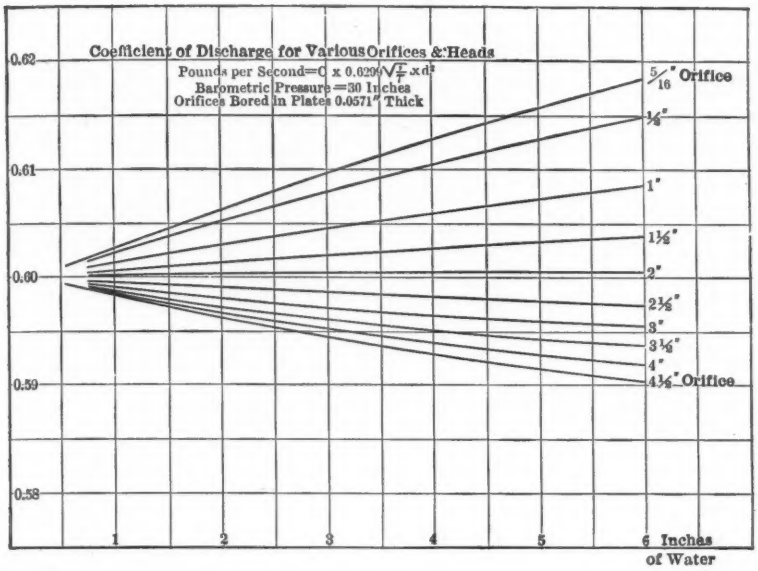


TABLE X.

No. of trial	Diam. of Orifice ins.	Head ins. water	Duration of trial. Secs.	Reservoir				Box Temp. Abs.	Actual discharge Lbs. Sec.	Corrected actual discharge at 60° F. and 14.7 lbs.
				Abs. Pressure		Abs. Temperature				
				Initial.	Final.	Initial.	Final.			
60	2	1	347.2	92.1	42.5	524.6	510.1	511.0	.06613	.06521
61	"	1	332.0	87.0	37.5	539.8	510.6	513.2	.06579	.06503
62	"	1	335.2	87.0	37.5	536.4	512.8	516.7	.06613	.06539
63	"	2	240.5	82.0	32.6	537.2	511.4	513.0	.09191	.09097
64	"	2	242.0	87.0	37.5	525.5	511.5	517.1	.09479	.09416
65	"	2	232.7	94.8	44.8	534.5	511.3	521.2	.09632	.09600
66	"	3	240.0	95.8	36.0	526.2	516.4	512.6	.1165	.1153
67	"	3	240.0	94.8	35.3	525.6	522.3	513.3	.1168	.1157
68	"	3	240.0	91.8	32.4	525.5	520.1	514.7	.1165	.1155
69	"	3	210.0	93.1	41.1	526.2	524.1	513.6	.1167	.1156
70	"	4	150.0	89.3	45.7	525.5	523.9	514.4	.1371	.1358
71	"	4	150.0	88.8	45.9	526.0	521.9	514.9	.1343	.1333
72	"	4	150.0	96.6	53.8	527.3	519.7	515.0	.1322	.1312
73	"	5	119.31	92.2	54.3	523.3	521.4	517.5	.1502	.1494
74	"	5	113.93	90.6	54.6	524.6	523.0	516.1	.1491	.1481
75	"	5	132.18	96.8	55.1	524.5	522.2	514.3	.1489	.1476

TABLE XI.

No. of trial	Diam. of Orifice ins.	Head ins. water	Duration of trial. Secs.	Reservoir				Box Temp. Abs.	Actual discharge Lbs. Sec.	Corrected actual discharge at 60° F. and 14.7 lbs.
				Abs. Pressure		Abs. Temperature				
				Initial.	Final.	Initial.	Final.			
76	2½	1	299.8	92.8	26.5	523.7	515.6	516.1	.1042	.1034
77	"	1	300.0	93.8	27.4	523.2	515.0	513.3	.1046	.1036
78	"	1	299.5	92.9	25.9	522.8	516.1	511.9	.1059	.1047
79	"	1	300.0	93.3	26.6	524.9	514.0	511.1	.1046	.1034
80	"	2	139.0	90.6	48.1	516.7	515.5	510.7	.1470	.1453
81	"	2	150.0	90.38	42.92	521.1	515.8	513.6	.1499	.1486
82	"	3	178.2	92.1	22.3	532.8	506.8	509.8	.1800	.1780
83	"	3	105.0	87.5	48.4	513.8	515.3	512.8	.1810	.1793
84	"	3	110.0	89.93	48.15	522.2	518.1	512.3	.1793	.1776
85	"	4	126.6	92.1	32.6	545.8	509.2	511.5	.2059	.2038
86	"	4	99.0	90.96	47.33	521.5	514.6	514.7	.2074	.2059
87	"	4	98.66	86.0	42.8	523.4	516.9	512.9	.2058	.2039
88	"	5	111.4	89.0	32.6	526.0	507.7	513.8	.2346	.2328
89	"	5	114.8	92.1	32.6	537.1	509.7	509.1	.2335	.2306
90	"	5	115.8	96.7	36.5	537.3	508.7	505.8	.2327	.2290

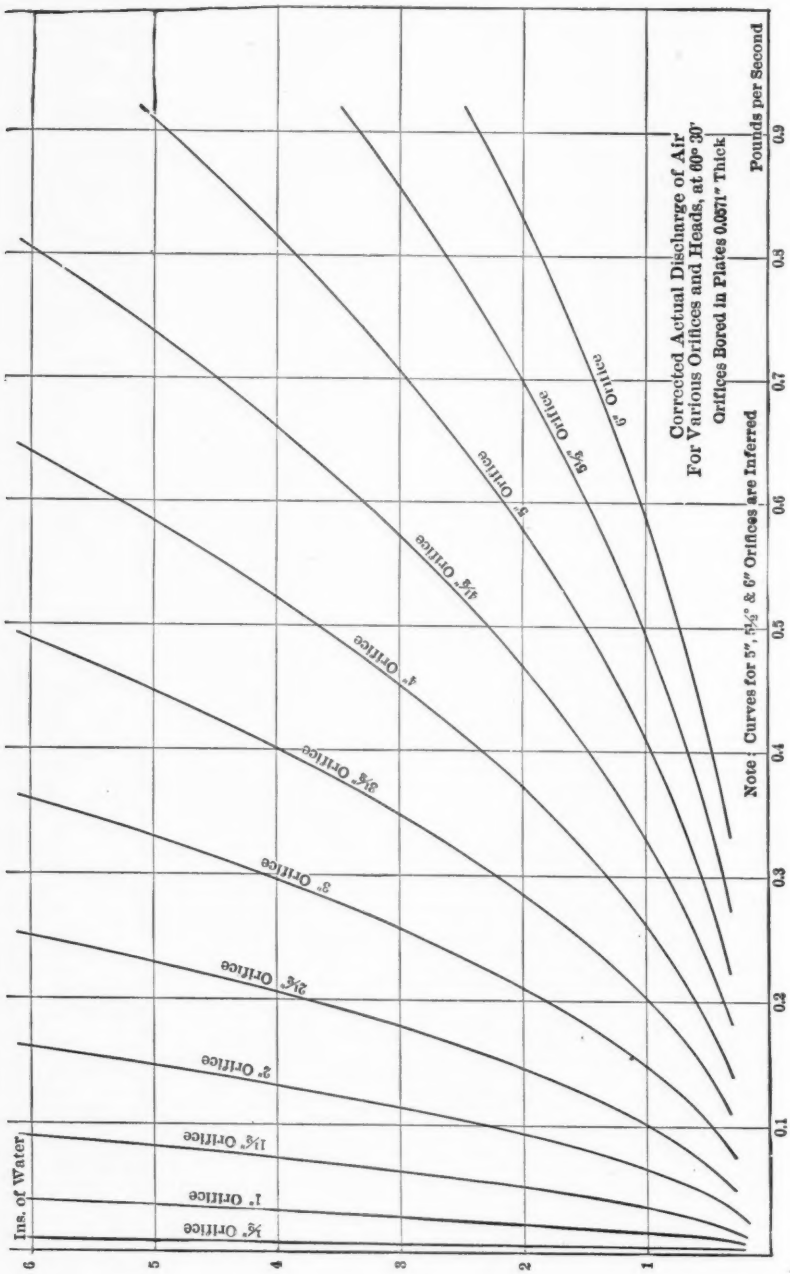

Corrected Actual Discharge of Air
For Various Orifices and Heads, at 60° 30"
Orifices Bored in Plates 0.0571" Thick
Note | Curves for 5", 5½" & 6" Orifices are Inferred
Pounds per Second
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Ins. of Water
6
5
4
3
2
1
¼" Orifice
½" Orifice
1" Orifice
1¼" Orifice
2" Orifice
2½" Orifice
3" Orifice
3½" Orifice
4" Orifice
4½" Orifice
5" Orifice
6" Orifice

FIG. 7.

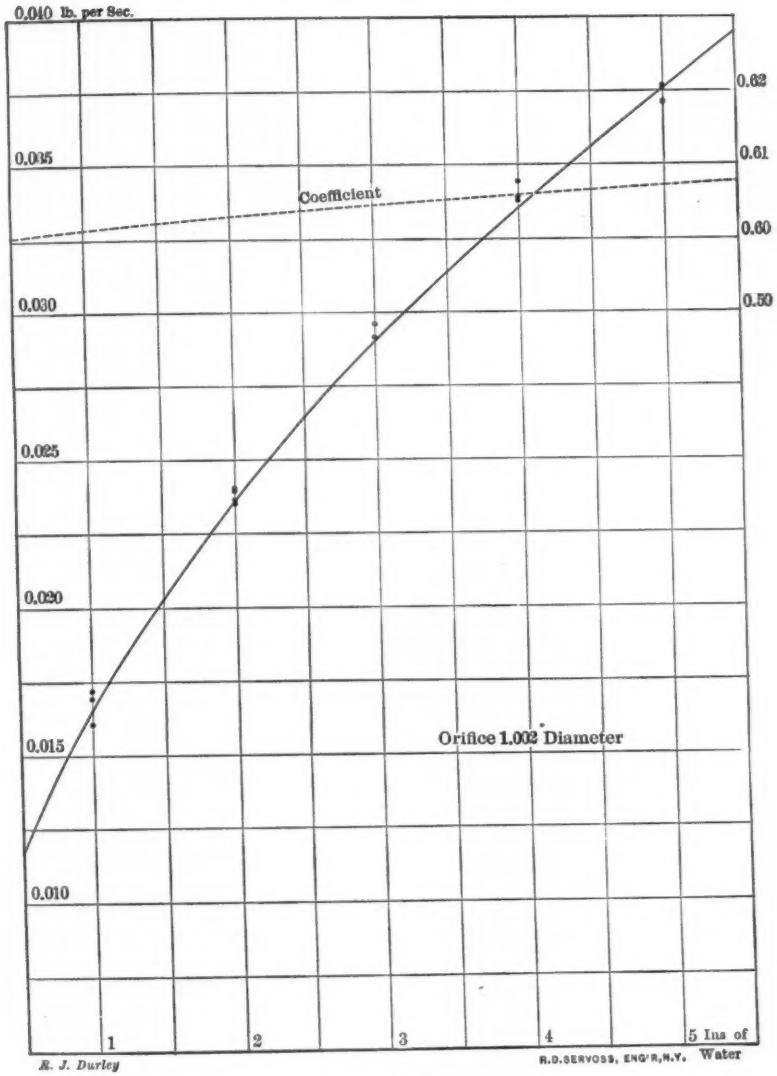

0.040 lb. per Sec.
0.035
0.030
0.025
0.020
0.015
0.010
0.62
0.61
0.60
0.59
Coefficient
Orifice 1.002 Diameter
1
2
3
4
5 Ins of Water
E. J. Durley
R.D.SERVOSS, ENG'R,N.Y.

FIG. 8.

TABLE XII.

No. of trial	Diam. of Orifice ins.	Head ins. water	Duration of trial. Secs.	Reservoir				Box Temp. Abs.	Actual discharge Lbs. Sec.	Corrected actual discharge at 60° F. and 14.7 lbs.
				Abs. Pressure		Abs. Temperature				
				Initial.	Final.	Initial.	Final.			
91	3	1	150.17	98.3	49.6	524.4	521.2	513.2	.1530	.1513
92	"	1	148.32	96.5	48.5	524.4	522.8	513.8	.1532	.1513
93	"	1	153.63	95.9	45.8	526.6	523.0	512.1	.1531	.1509
94	"	2	86.21	92.1	53.1	523.9	523.6	513.5	.2147	.2111
95	"	2	93.72	93.0	50.8	519.0	517.4	512.6	.2138	.2107
96	"	2	74.95	93.2	59.3	520.0	519.3	509.9	.2161	.2114
97	"	3	67.32	99.1	62.0	519.9	517.6	509.3	.2613	.2567
98	"	3	73.20	94.0	53.6	520.3	519.5	512.5	.2638	.2591
99	"	3	44.45	99.2	73.7	521.8	511.4	509.5	.2569	.2533
100	"	4	47.92	94.8	63.0	519.8	508.8	509.3	.3043	.3006
101	"	4	45.54	97.1	68.3	519.2	517.0	511.5	.2995	.2944
102	"	4	55.15	100.7	65.6	521.8	517.5	509.7	.2986	.2941
103	"	5	42.97	90.0	59.3	519.3	516.9	510.4	.3388	.3336
104	"	5	50.23	98.0	62.4	520.1	518.8	505.7	.3373	.3292
105	"	5	43.27	94.6	63.1	518.8	518.6	506.3	.3490	.3397

TABLE XIII.

No. of trial	Diam of Orifice ins.	Head ins. water	Duration of trial. Secs.	Reservoir				Box Temp. Abs.	Actual discharge Lbs. Sec.	Corrected actual discharge at 60° F. and 14.7 lbs.
				Abs. Pressure		Abs. Temperature				
				Initial.	Final.	Initial.	Final.			
106	3½	1	72.10	99.5	67.6	520.2	518.7	505.5	.2105	.2051
107	"	1	67.35	98.5	69.1	519.6	517.6	505.7	.2069	.2020
108	"	2	52.2	100.4	68.7	520.4	518.9	505.2	.2889	.2810
109	"	2	68.78	99.1	56.8	520.1	518.1	503.7	.2926	.2862
110	"	2	54.59	98.3	64.9	520.3	519.7	505.1	.2926	.2847
111	"	3	41.04	96.23	65.60	519.8	517.9	507.2	.3541	.3458
112	"	3	69.2	89.7	38.3	522.5	512.1	509.2	.3481	.3442
113	"	3	75.0	89.0	32.2	520.0	515.5	511.2	.3543	.3509
114	"	4	34.04	98.33	69.28	521.5	519.6	505.7	.4042	.3945
115	"	4	60.5	86.9	34.9	520.3	515.7	503.5	.4084	.4012
116	"	4	68.5	90.9	32.4	521.0	511.8	506.4	.4039	.3984
117	"	5	29.35	95.15	66.21	519.2	513.1	507.0	.4595	.4518
118	"	5	30.12	95.41	65.94	520.3	519.2	506.6	.4650	.4545
119	"	5	31.22	97.69	66.92	520.7	520.1	505.1	.4702	.4572

TABLE XIV.

No. of trial	Diam. of Orifice ins.	Head ins. water	Duration of trial. Secs.	Reservoir				Box Temp. Abs.	Actual discharge Lbs. Sec.	Corrected actual discharge at 60° F, and 14.7 lbs.
				Abs. Pressure		Abs. Temperature				
				Initial.	Final.	Initial.	Final.			
120	4	1	54.89	98.00	66.57	520.6	518.9	507.8	.2715	.2657
121	"	1	48.69	96.56	68.56	522.0	519.3	506.7	.2745	.2684
122	"	1	47.46	97.30	70.03	521.6	518.3	506.6	.2696	.2642
123	"	2	36.08	96.31	67.24	521.1	520.0	505.4	.3820	.3722
124	"	2	38.60	97.39	65.60	521.6	518.9	505.2	.3887	.3805
125	"	2	40.6	97.15	63.73	520.8	517.0	507.7	.3880	.3811
126	"	3	53.5	89.6	37.1	523.7	519.7	508.3	.4636	.4578
127	"	3	54.6	91.8	37.2	524.3	514.5	506.8	.4684	.4620
128	"	4	22.69	94.65	69.07	521.4	518.6	504.8	.5319	.5189
129	"	4	21.66	95.49	70.63	521.4	517.0	503.6	.5330	.5191
130	"	4	42.5	91.2	43.0	524.3	514.8	506.0	.5298	.5221
131	"	5	19.91	96.55	71.33	520.5	519.1	503.7	.6125	.5970
132	"	5	20.32	97.35	71.17	519.8	518.7	503.4	.6135	.5967
133	"	5	20 68	93.94	67.75	520.1	516.4	504.6	.5943	.5819

TABLE XV.

No. of trial	Diam. of Orifice ins	Head ins. water	Duration of trial. Secs.	Reservoir				Box Temp. Abs.	Actual discharge Lbs. Sec.	Corrected actual discharge at 60° F. and 14.7 lbs.
				Abs. Pressure		Abs. Temperature				
				Initial.	Final.	Initial.	Final.			
134	4½	1	38.00	97.85	69.83	521.0	519.4	504.8	.3489	.3406
135	"	1	47.83	102 48	66.96	525.5	518.9	507.3	.3429	.3373
136	"	1	40.25	97.13	67.37	520.9	518.9	506.2	.3505	.3438
137	"	2	23.57	99.0	74.6	522.1	518.9	506.2	.4834	.4727
138	"	2	25.89	93.50	65.77	515.9	512.7	505 4	.5086	.4984
139	"	3	23.79	96.31	65.18	515.7	512.9	503.8	.6233	.6085
140	"	3	25.65	97.74	64.40	515.4	516.0	503.4	.6295	.6099
141	"	3	23.82	95.77	64.77	515.0	515.8	503.4	·6308	.6119
142	"	4	21.46	96.82	64.62	515.3	515.4	503.5	.7247	.7044
143	"	4	21.31	94.35	63.30	515.2	515.8	503.4	.7052	.6832
144	"	4	37.00	94.47	39.95	515.1	514.5	498.9	.7112	.6925
145	"	5	29.06	93.40	44.37	515.9	515.0	498.2	.8121	.7902
146	'	5	29.71	93.43	44.80	515.9	516.3	496.5	.7893	.7664
147	3	1	93.85	96.61	65.90	520.2	517.9	509.1	.1548	.1512
148	"	1	87.81	97.21	68.31	521.1	519.0	508.0	.1556	.1515
149	"	5	36.59	92.35	63.41	520.2	518.1	504.7	.3767	.3675
150	"	5	34.74	91.02	63.41	520.3	519.8	504.4	.3796	.3679

TABLE XVI

No. of trial	Diam of Orifice ins.	Head ins water	Duration of trial. Secs.	Reservoir				Box Temp. Abs.	Actual discharge Lbs. Sec.	Corrected actual discharge at 60° F. and 14.7 lbs.
				Abs. Pressure		Abs. Temperature				
				Initial.	Final.	Initial.	Final.			
151	1	3	1,020	91.3	27.5	522.6	518.2	516.1	.02968	.02938
152	1	3	600.0	93.9	55.9	525.4	517.9	525.5	.02936	.02901
153	1	3	600.0	87.2	49.1	526.3	517.4	525.9	.02936	.02934
154	1	3	600.0	94.2	56.1	527.5	517.8	526.3	.02916	.02881
155	1	3	600.0	90.6	52.6	531.7	519.1	537.0	.02861	.02827
156	1	3	600.0	89.3	52.2	524.0	519.3	542,4	.02898	.02864
157	1	3	600.0	87.6	50.5	525.6	518.0	546.8	.02865	.02832
158	1	3	600.0	92.1	52.0	531.8	517.7	548.1	.03018	.02984
159	1	3	599.5	86.3	50.2	524.8	518.4	549.6	.02803	.02767
160	1	3	599.0	90.6	55.1	533.5	522.4	561.8	.02675	.02637
161	1	3	600.0	91.8	51.5	531.3	517.3	563.3	.03038	.03004
162	1	3	599.4	80.0	46.0	523.7	520.1	567.6	.02671	.02636

ELECTRICITY AND COMPRESSED AIR.

What is technically known as the electro-pneumatic switch has been installed at the Newcastle Central Railway Station, Newcastle, England, for the purpose of dealing with the traffic at the west end of the station, which will be considerably increased when the new High Level Bridge is opened.

The necessary plant for working the system has been laid down under the north wing of the old High Level, and the new order of things is expected to come into operation in August.

One of its advantages is that manual exertion is reduced to a minimum. All the signalmen will be required to do to change the position of points or signals will be to shaft a small lever, which can be freely worked with the finger and thumb. Compressed air will do the remainder.

The plant comprises two 35 horse-power gas engines, with combined air compressers, and a 30 horse-power electric motor, also fitted with a combined air compresser.

These generate the compressed air by which the points and signals are worked, provision being made for storing the electricity for set-the air in motion.

At the west end of the station a new signal box has been erected from which will be manipulated 182 signals and 136 pairs of points by 211 levers. In many cases a single lever works two and more signals and points. 83 levers to be installed will command 60 south end of the new High Level, and the

A signal cabin has also been built at the signals and 34 pairs of points and bars.

Pipes are to be laid from the signal boxes to the points and signals, and a uniform pressure of 65 pounds of compressed air will be maintained, the working of the motive power being done electrically by connection with the levers.—*Exchange.*

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Established 1896.

A monthly magazine devoted to the useful applications of compressed air.

W. L. SAUNDERS, M. Am. Soc. C. E., . Editor
W. R. HULBERT, M. E., . Managing Editor
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CONTENTS.

Vacuum Peculiarities 4211
A New Ashpit 4215
An Improved Triple Valve..... 4220
The Education of Mining Engineers.. 4221
On the Measurement of Air Flowing Into the Atmosphere Through Circular Orifices in Thin Plates and Under Small Differences of Pressure 4223
Editorials:—
The Education of Engineers. Are We Being Superseded. Living in Compressed Air 4232
New Publications 4234
Trade Publications 4234
Industrial:—
A New Air Compressor. The Konomax Rock Drill. Compressed Air Forges. Japan's Growing Influence in China. New Process of Turning Ore Into Iron and Steel..... 4235
Practical Items for Practical Men..... 4240
Chippings 4242
United States Patents 4244
Office Chit-Chat 4246

THE EDUCATION OF ENGINEERS

We print in this issue of COMPRESSED AIR an abstract of a paper read recently before the Institution of Mining Engineers at London, on "The Education of Mining Engineers," in which many important subjects are taken up relative to obtaining the most advantageous curriculum. Now we note that not one word is ever said about compressed air as being a subject of study in papers such as this, and, with one exception, we do not know of any college of university in the United States or England which gives courses in this subject. The one exception is New York University, where a comprehensive course in compressed air and its applications is delivered by Prof. D. W. Hering of the Department of physics. Why is it that this important subject has received so little attention from our colleges and scientific schools? The field of compressed air is an exceedingly broad one and would certainly justify the establishing of such a course.

The capital involved in the manufacture of compressed air machinery is very great and, while not perhaps so large as that involved in the manufacture of electrical apparatus, it is still a big factor in our industrial system. When a branch of engineering supports such large concerns as the Ingersoll-Rand Co., Chicago Pneumatic Tool Co., Sullivan Machinery Co., and many other concerns of prominence, it seems to us that it should receive attention in our colleges and technical schools. Such is not the case, however, and, while many colleges are devoting months and even years to the subjects of electricity and direct combustion engines, compressed air is entirely neglected.

For this reason, when the young technical graduate takes a position with any of the companies such as mentioned above, he has to spend many months of hard study before he is fitted for an important position; while, if a short course were given on the theory and practice of compressed air, much time and trouble would be saved later on. A short time ago we printed an article on the training of apprentices at the shops of the Rand Drill Company, at Tarrytown, N. Y., in which the writer stated that six months were required for these young engineers to learn the rudiments of their chosen profession, and it was necessary that the knowledge gained by experience in the shops be supplemented by numer-

ous lectures and examination questions before the apprentice was deemed of sufficient value to receive a position in one of the branch offices of the company. Even then, however, his education was not complete and it required at least two months more to become familiar enough with compressed air theory to be trusted with the "figuring out" of a plant. We certainly hope that some of our universities will establish courses in compressed air and follow in the foot-steps of the New York University in training young men for this most important subject.

ARE WE BEING SUPERSEDED?

For ten years COMPRESSED AIR has harbored the impression that it was secure in its chosen field, thus far nothing having been perfected to take its place. Electricity has given us a few spasms now and then, but the fright soon passed off leaving us more secure than ever. Now, however, we receive word that a new medium for the transmission of power is coming to the front. One of the latest monographs of the United States Geological Survey is devoted to what is in a certain sense a new industry. This is nothing less than the extraction from the earth of natural carbonic acid gas. Beneath the surface of the earth in and near Saratoga, for instance, is an immense reservoir of carbon dioxide, and the business of utilizing its contents, independently of the bottling of the waters for which that locality has long been famous, is now conducted on a large scale. The daily output of the gas wells is not far from twenty thousand pounds, and fully half that amount is recovered and marketed, first going through a process that robs it of its moisture and then being highly compressed for shipment in steel cylinders.

The most interesting point in connection with the use of this gas, says the report, is that in some localities its service is by no means limited to the production of soda water and the imparting of effervescence to other beverages. The compressed gas being used in place of compressed air for the operation of block signals on railways, possibly because it is more economical in some localities to rely on cylinders of gas than to install a compressor plant. Again in Europe it is employed more extensively than in the United States for mechanical refrigeration. The machinery in which it is used is more compact than that required with ammonia. Pressures of 1,000 to 1,200 pounds to the square inch are deemed not only feasible but safe with carbon dioxide, while 150 to 200 pounds represent the common practice with ammonia. Besides, when an explosion suddenly liberates a large quantity of ammonia vapor the effect is often fatal to those in the immediate vicinity. No such consequences attend the escape of carbonic acid gas.

As a result of all these discoveries it would seem as though we ought to warn our subscribers that perhaps they may wake up some morning to find that the name of this paper has been changed from COMPRESSED AIR to "CARBONIC ACID GAS," "CARBON DIOXIDE," or plain "CO ."

LIVING IN COMPRESSED AIR.

The Royal Society has just issued a first report of some interesting experiments lately undertaken by two Englishmen of science, Dr. Leonard Hill and Mr. M. Greenwood, with a view to ascertaining the effects of compressed air on the human system. These experiments throw some light upon some obscure points in physiology, but they have a practical value altogether apart from their medical, or scientific, aspect.

It is well known that divers can not descend more than a certain depth below the surface of the water, primarily because the diving dress must have compressed air inside it in order to resist the pressure of water outside, and, roughly speaking, one atmosphere has to be forced in for every distance of thirty-four feet below the level of the water.

Thus, at a depth of 170 feet, a pressure of five atmospheres is necessary. Few divers, however, have ever descended so far. The record dive is 204 feet, but the unfortunate man who accomplished it paid for it with his life. At depths of about 100 feet a danger signal is usually hoisted. The British Admiralty adopt 120 feet as the limit of their operations, but this has been surpassed many times by men working for private firms.

There is much buried treasure, some of which is located on charts, but with our present appliances it is hopeless to attempt to recover any of it. Any improvement, therefore, in methods of diving is of considerable importance.

Dr. Hill explained that Mr. Greenwood and himself had been trying the effect of com-

pressed air upon themselves, and for this purpose they had had constructed a large steel cylinder, of rather more than forty-two cubic feet capacity, with a moter-driven pump for compression and taps for letting out the air, or, as it is called, decompression.

They were subjected to a pressure of about five atmospheres, equivalent to a depth of 170 feet. Mr. Greenwood successfully resisted seven atmospheres, which meant that he could dive to a depth of considerably over 200 feet. They had previously tried experiments on various animals—dogs, cats, rats, mice and monkeys—and found that they could resist eight, nine, and even ten atmospheres.

As a result of their experiments they have ascertained that divers' deaths were due to the fact that the men were brought to the surface too rapidly. Time should be allowed for decompressure and all would be well.

Dr. Hill said his impression was that the functions of the body were normal in compressed air. They stayed in the apparatus four or five hours and measured their respiration, took notes of the state of the blood, and so forth.

Dr. Hill said that no doubt men would go far deeper in the future than they had done. It would certainly be less dangerous than looping the loop. They had a monkey who was subjected to eight atmospheres three times a week for four hours at a time, during a whole month, and he never had the slightest unfavorable symptom.

Dr. Hill's apparatus is a great boiler-like cylinder with a hole at the side scarcely bigger than the porthole of a steamer. Through this hole he creeps with considerable difficulty and lies at full length on a matress inside, while an iron clamp is fixed with great nuts screwed tight by a giant spanner. There is a small electric light inside, and communication is carried on with the inmate by means of a telephone.

NEW PUBLICATIONS.

Electrically-Driven Air Compressors.—THOMPSON.—A paper read before the British Institution of Mining Engineers on the use of electrically-driven air compressors at the Ouston Colliery. It was found at that mine that electricity at the coal face was out of question, owing to the amount of gas given off by the Busty seam. On the other hand, a well-equipped modern electric station had been put down at the pit. It was then concluded that it would be cheaper to utilize the plant for generating electric current to be transmitted to electrically-driven air compressors than to put down at the bank, in addition, a steam-driven air compressor plant and to conduct air to the face in the usual way. Moreover, electric cables can be placed in the shaft and along the roadways more easily than bulky air pipes. The installation is described; in two tests efficiencies of 62 and 60 per cent of the plant were found, which is thought to compare favorably with that of any steam-driven air compressor plant.

"The Abuses of Valves," published in *The Valve World*, by Mr. R. T. Crane, president of Crane Co., says that in 95 cases out of 100 leaky valves are due to abuse and carelessness on the part of the men who install them, rather than to defects in the valves themselves. If the few simple directions given by Mr. Crane for the installation and care of valves were generally followed much of the annoyance and expense due to leaky valves would be avoided. The article has been printed in the form of a poster suitable for hanging on the walls of engine rooms and shops, and all users of valves may obtain one or more copies free by writing Crane Co., Chicago. The posters are legibly printed in two colors on heavy calendered bristol board, and contain no advertising other than the name of the publisher.

TRADE PUBLICATIONS.

SULLIVAN MACHINERY COMPANY, Railway Exchange Building. Chicago, Ill.—Modern Methods of Producing Coal. Part 1. A handsomely illustrated booklet, 6x9, devoted to descriptions of the Sullivan Pick Machine for undermining coal. This book also contains some valuable statistics on bituminous coal production in the United States, average prices per net ton, approximate analysis and heating value of American coals, etc. This catalog is known as Catalog No. 57.

EDISON MANUFACTURING COMPANY, Orange, N. J.—Illustrated booklet describing Edison Primary Batteries (formerly known as Edison-Lalande) and the Edison Spark Coil.

COOPER-HEWITT LAMP COMPANY, Garrison Place and Fayette street, Pittsburgh, Pa.—The Economical Lighting of Industrial Plants. Booklet 5x7¾, describing the Cooper-Hewitt Mercury-Vapor Lamp as adapted to lighting manufacturing plants, offices, drafting rooms, etc.

THE NERNST LAMP COMPANY, Pittsburgh, Pa.—Booklet 6x9, illustrating the design and application of Nernst Lamps for Electric Lighting.

STEEL CITY ELECTRIC COMPANY, Third street and Pennsylvania avenue, Pittsburgh, Pa.—Small booklet devoted to Star Bushings and other contractor's supplies.

BALDWIN LOCOMOTIVE WORKS, Philadelphia, Pa.—Record of Recent Construction, No. 56, being a description of the Atchison, Topeka & Santa Fe Railway System and the locomotives constructed for this system by the Baldwin Locomotive Works since 1875.

WESTERN WHEELED SCRAPER COMPANY, Aurora, Ill.—Profusely illustrated catalog describing Standard Western Wheeled Scrapers, Drag Scrapers, Railroad Plows, Road Machines and Ditchers, Western Air Dump Cars, etc. This catalog is submitted by M. E. Davis, Eastern Agent, 829 Park Row Building, New York City.

KILBOURNE & JACOBS MANUFACTURING COMPANY, Columbus, Ohio.—Catalog No. 32-D describing Contractors' Dump Cars, Steam Shovel Cars, Hopper Cars, Track Laying Cars, Quarry Cars and Contractors' Dump Carts.

CHEAP oxygen is the one important product thus far obtained from liquid air, for which such extravagant prophecies have been made. As the nitrogen and oxygen of the liquid air return to the gaseous state, at different temperatures, it has proven to be possible to separate them by fractional distillation, and as the evaporation of the gases cools the air entering to be compressed in the apparatus, the process is very economical. An idea of this efficiency has lately been given by M. Georges Claude. His plant produces 1,000 cubic metres of oxygen with a purity of 96 to 98 per cent. in 24 hours, and the cost in France is only one-twentieth of that of oxygen from the electrolytic decomposition of water.

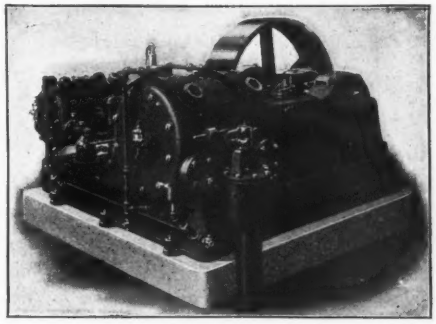
The use of underground compressors obviates a loss by friction in transmission and also makes possible a saving in labor, as the man in charge can also attend to other duties. There is sometimes a disadvantage in that the air compressed may be foul and therefore unfit for ventilation at the headings. Every mining engineer must be his own judge as to the desirability of an underground compressor for his particular case—*Mining Reporter.*

Newport, R. I., July 25. A whitehead torpedo fired from the dock at the torpedo station during practice to-day struck and sank a hole in the boat a distance of three hundred seated. A life boat rescued the seamen. The torpedo was not charged, but it was driven with sufficient force by compressed air to break a hole in the boat a distance o fthree hundred yards. The men in the boat were standing on the range to pick up the spent torpedo.

INDUSTRIAL.

A NEW AIR COMPRESSOR.

The accompanying engravings illustrate a new type of Sullivan air compressor, which is particularly suited to the requirements of mines and quarries, as well as for industrial purposes of various kinds. This machine is of the duplex pattern, and is built in several combinations of steam and air cylinders, also for belt and power drive. The dominant feature of these various types is the box frame, with housing, which forms a tight enclosure about the crank discs, main bearings, eccentrics, connecting rods and crossheads. This housing excludes dust and dirt, and permits the use of a system of self-lubrication of the principal



EXTERIOR VIEW OF NEW SULLIVAN AIR COMPRESSOR.

working parts. As shown in the sectional view, an oil well is provided in each frame, in which the lower edges of the crank discs are immersed. The oil clinging to the discs is removed by scrapers in contact with their upper edges, and thence conveyed, by means of a storage chamber and suitable pipes, to the main journals, crank pins, eccentrics and cross-head guides, being finally returned to the well by gravity to be used again. These machines require the minimum of attention and care, as it is necessary to add oil to the wells only at long intervals.

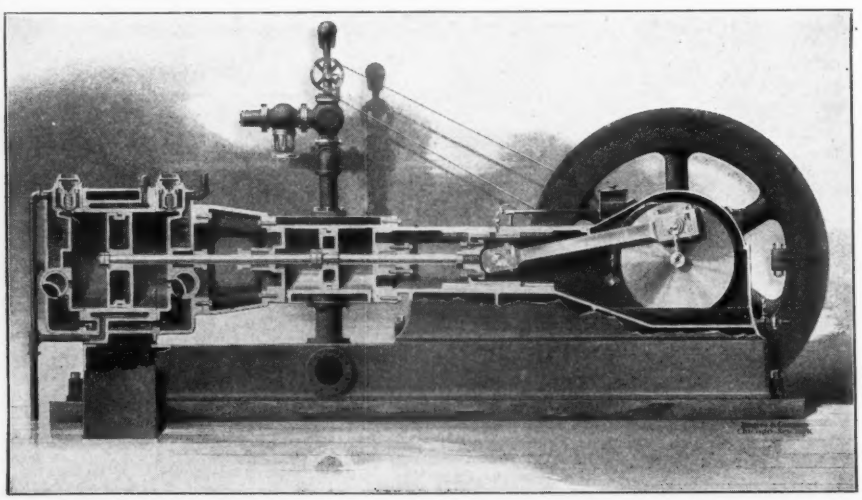
These compressors are very compactly and substantially built. All sizes except those of largest capacity are mounted on a heavy subbase, in which the inter-cooler and steam reheater (on cross-compound machines) are situated. The frames are of the heavy duty type or tangye pattern, with long bearings on the base, securing rigidity, and maintenance of correct alignment of working parts. The steam valve gear is controlled by a Meyer ad-

justable cut-off, the throttle being regulated by a sensitive steam and air governor.

The air cylinders are not cored out, but instead, separate liners are forced into the castings, thus precluding shrinkage strains. The space between the liner and the cylinder forms the water jacket, and outside of this again is the air inlet passage. Incoming air is thus admitted to the cylinder without contact with heated walls.

The air cylinder heads are also water jacketed, and in two-stage compressors, an efficient inter-cooler is provided, consisting of a nest of cold water tubes, made of copper, with

thin film of air to get behind the closed valve, pressing the cutting edges to the seat, and making the valve tight against leakage. The valve stems have T-shaped heads on their inner ends, carefully planed and fitted to the slots in the ends of the valves. The attachment is such that the valves are free to follow up wear automatically without hindrance from the stems. These valves may be removed through the back bonnets without disturbing the setting of the valve gear. This valve gear is simple, strong and durable, is positive and reliable in action, and insures high volumetric efficiency.



SECTIONAL VIEW OF NEW SULLIVAN AIR COMPRESSOR.

whose cold surfaces the air is forced to come into intimate contact in passing from the low to the high pressure cylinder.

The inlet valves on all air cylinders are of the semi-rotary or Corliss type, and are moved by steel valve stems, connected by adjustable connecting rods to independent eccentrics on the engine shaft. The moving parts start from and arrive at the ends of their travel with a slow and easy motion, but at the points of opening and closing of the valves, these parts attain their greatest speed; it is thus possible for the valves to remain open during the entire stroke, allowing the cylinder to fill with air at barometric pressure, and trapping it instantly before the piston begins its return.

The valves themselves are made of close-grained semi-steel, of large diameter, fitted with accuracy. Provision is made to permit a

The discharge valves are placed radially on top of the cylinder head castings. They are set with removable seats in shallow ports or pockets, as shown in the sectional view of the class WE machine referred to above, at a sufficient distance from the ends of the cylinder so that the piston travels completely past the openings to these pockets, at each end of the stroke, thereby reducing clearance to the smallest amount possible. These valves are of poppet type, internally guided on cast iron plugs and held to their seats by light steel springs. They are seated in bronze cages, readily removable by unscrewing the valve plug. As shown by the sectional view, they are completely surrounded by water jackets, in order to reduce the temperature of the air at its terminal pressure.

All working parts are constructed of mater-

ials which experience has shown to be best suited for their respective purposes, and all parts of the machines are readily accessible for inspection or repair.

These air compressors are built in capacities ranging from 100 to 2,600 cubic feet of free air per minute. The makers, the Sullivan Machinery Co., of Chicago, state that they have erected large additions at their works at Claremont, N. H., for the proper manufacture of this type of compressor.

THE Sierra Consolidated Gold Mining Co., of Millsboro, N. M., has placed a large contract with the Traylor Engineering Co., of New York, for hoisting, pumping and electrical machinery, and the steel and iron work necessary for a complete hoisting and crushing plant, thus completing its outfit for taking out and treating its ores.

The order was placed through the Hon. Warner Miller, president of the company, from the New York office, 100 Broadway. The hoisting outfit is for a three-compartment vertical shaft, and there are to be two electric hoisting engines; one with a single drum to hold 1,000 feet of ⅝" wire rope, to lift 2,000 pounds at a rate of 300 feet per minute, and the other with two independent drums, each to hold 1,000 feet of 1" rope, and capable of lifting a load of 4,000 pounds at a rate of 500 feet per minute. The hoists are to be fitted with all the latest appliances for safety and convenience, and will be operated by 3 phase, 60 cycle, 220 volt, variable speed, external resistance, induction motors.

A complete electrically operated pumping plant is also included in the contract. This will require 17,000 feet of transmission wire to connect it with the power house, besides an entire equipment of piping, valves and other fittings. The current for operating the machinery will be generated by two 125 Kilowatt revolving field Generators, of the "Water Wheel" type, each one direct connected to a 170 H. P. American Diesel oil engine. The two Diesel engines and the generators are included in the contract. Other electrical equipment furnished by the Traylor Engineering Company will be, two 12½ Kilowatt, 125 volt, direct current generators; five 30 H. P., 200 volt motors, with auto-starters; one 15 H. P., 200 volt motor, with auto-starter; three Kilowatt step-up transformers for raising the line current voltage from 200 to 2,000 volts; three similar step-down transformers for reducing the line voltage from 2,000 to 200 volts; a complete switchboard, lamps for the mill, and the wire and other materials for the 17,000 feet of transmission line. The contract includes also a cage, skips, grizzley, ore bin gates, steel linings for the ore bins, a plunger feeder, a belt conveyor 100 feet long for taking ore from the crushing plant to the stamp mill bins, sheave wheels, an amalgam box and two steel tanks, one of about 96,000 gallons capacity, and the other of about 16,000 gallons.

THE Canadian Westinghouse Co., Ltd., is being called upon to supply apparatus for the operation of a number of single phase railway lines. A recent contract is for furnishing their latest type of alternating current single phase railway equipment for approximately 35 miles of track, for the Windsor, Essex & Lake Shore Rapid Railway Co. For the present, five cars equipped with two 100 H. P. motors each, will be operated, in addition to which the order covers a 500 K. W., single phase, 25 cycle generator to be installed in the main power house near Essex, together with switchboards, exciters and transformers, for operating the system. A trolley voltage of 6,600 will be used and the most improved type of catenary line construction will be installed throughout the system.

The Stanley-G. I. Electric Manufacturing Company, of Pittsfield, Mass, have just placed on the market a new and novel form of induction motor made in various sizes up to 7½ H. P. The novel feature of this motor is in having the laminated iron core of the stator freely exposed to the air around its entire periphery. Because of the fact that the frame is held together by means of a riveted construction, the motor will be known as the riveted frame type. The cast-iron ribs which are used with the ordinary induction motors are entirely done away with and thereby all metal is used to much higher efficiency than ever before attained in induction motor design.

IT would be dangerous to attempt to operate a hoisting engine in lowering a bucket, skip, or cage, depending wholly on the air compressed in the engine-cylinder by the reciprocal movement of the piston to act as a brake without any other means of control. Engines are made having auxiliary cylinders set tandem with the engine cylinders and connected with the air-receiver of a compressor, but this style of brake arrangement has not become popular as yet. The best type of hoisting-engine control is the post-brake, though many believe the band-brake and the end-friction brake are equally safe. Some large hoisting engines have steam-brakes which are usually set unless the steam is shut off. These brakes operate automatically.

THE KONOMAX ROCK DRILL.

The "Johannesburg Star" of a recent date gives particulars of a new drill now working on the Village Main Reef, as follows: "The 'Konomax' drill is so styled because it gives the maximum economy in power. It uses considerably less air per blow than any other rock drill, while at the same time the blow is none the less powerful—in fact, it is more powerful. The blow is obtained from a piston stroke, during the whole of which the full air-pressure is maintained as the driving force, and as, owing to the shortness of the exhaust passage, back-pressure is reduced to a minimum, it will readily be seen that no other drill with the same size driving piston can be quite as powerful.

"The economy in compressed air is effected by utilizing the property of expansion on the return stroke. The degree of expansion, and therefore the extent of economy, is only limited by freezing difficulties. In the 'Konomax' drill, however, an expansion of 3 to 1 has been attained, this being due to two facts: (1) To the simplicity of the exhaust arrangements, which allow any particles of ice which may form to be quickly and safely evacuated. The valve-box is situated at the front end of the cylinder, and allows a perfectly straight and practically unobstructed exhaust. (2) The apparatus is itself, to a great extent, a reheater.

"The piston itself consists of two portions of different diameters, working in a corresponding double cylinder. The rear cylinder is considerably the smaller and is in constant and uninterrupted communication with the maximum air-pressure in the mains. The front cylinder, in which the larger piston effects the return stroke, is under pressure as regulated by the admission and cut-off air controlled by the varying position of the piston. The cut-off is arranged so as to give the requisite expansion and economical working of the driving-fluid.

"One advantage of the very greatest importance, which has been alluded to, results from the fact that no fluid-distributing device is employed in connection with the rear end of the cylinder, so that the operating valve is enabled to be located at the cylinder head, and the ports governed by the valve can, therefore, be made very short and practically straight. The weight of the 'Konomax' drill compares very favorably with that of any other rock drill of the same power.

"The handiness of the 'Konomax' drill is much superior to that of any other rock drill, owing to the fact that the short starting strokes, incidental to the commencement of a hole, are obtained with the piston at the front end of the stroke. Any practical rock drill man will appreciate this great advantage over the ordinary drill, in which, to obtain the short strokes, it is compulsory to have the piston at the rear of the cylinder, thus involving subsequent 'racking back' to lengthen the stroke. With the 'Konomax' drill the necessity of the 'racking back' is avoided, as the maximum length of stroke can be instantly obtained."

Construction work for the completion of the American Pneumatic Service system in the City of New York was recently begun. The present contract calls for 25 miles of double lines of eight-inch tubes connecting the General Postoffice (including the present system) with the Produce Exchange, Wall street, Madison square and Grand Central station at 42d street, thence extending north as far as 125th street. The lines over the Brooklyn Bridge to the Brooklyn Post Office are to be still further extended, under the new appropriation bill passed by the House of Representatives, between three and four miles. This will make the total system in Greater New York over 29 miles of double tubes.

The service in Boston, Chicago and St. Louis is pronounced an ideal one by the postal officials in these different cities and permits of local distribution and train connection simply unattainable by any other means, and this rapid despatch in their judgment is largely accounted for by this great new facility.

AGAIN a workman, this time in the Homestead Steel Works, has been killed by compressed air being forced into his body by a joking fellow-workman. It would seem to be wise for the makers of compressed air tools to suggest to every customer that he have notices posted about the works stating the danger of playing with or perpetrating practical jokes with compressed air, and that when these notices have been duly posted, those who continue to play with it should be held legally responsible for the consequences of their acts.

COMPRESSED AIR FORGES.

Although the great power and adaptability of compressed air have been known for a long, time, new applications have been produced very slowly. Only recently the Buffalo Forge Co. of Buffalo, N. Y., has perfected attachments for the use of compressed air in producing the blast in its portable riveting forges.

One such application is shown by accompanying Fig. 1. In this design the air is admitted by a needle valve through two brass nozzles into a cast-iron mixer nozzle, and thence direct into the tuyere. By the use of this needle valve the volume of air furnished is varied

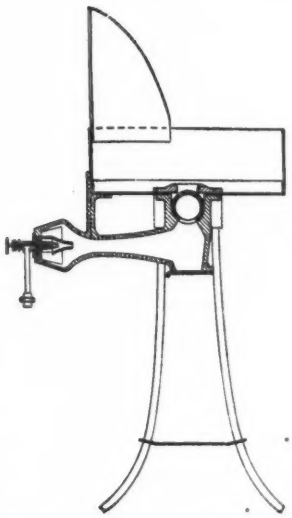


FIG. 2.—"BUFFALO" COMPRESSED-AIR FORGES.

without affecting the pressure, and by such compounding as shown the volume of air required is reduced by one-half.

Another application in which the compressed air acts directly upon the blast fan of the forge is shown by Fig. 2.

Extensive experiments show great economy in using the jet of air direct into the tuyere as described above, e. g., it takes one-ninth the amount of air to operate a forge in this manner that it does to operate the fan forge with compressed air (Fig. 2), and it takes one-fortieth as much as it does to operate the free-air forge with an ordinary blower. The pressure required is not high; in fact, very low pressures have been used advantageously.

The wide application of these forges for use on bridge and building construction, large railroad and repair shops, and, in fact, wherever compressed air is available, must be apparent to all, and the saving of time and labor in their usage, as well as the ease with which they may be connected by a small hose to the compressed air, should appeal to users everywhere.

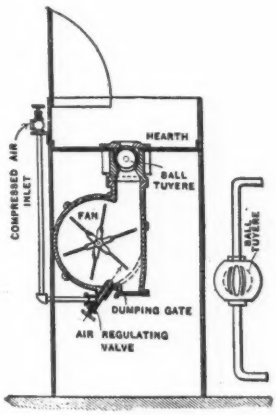


FIG. 1.—"BUFFALO" COMPRESSED-AIR FORGES.

Although the Buffalo Forge Co. makes both forges mentioned above, it recommends the compound compressed air operated on the injector principle (Fig. 1) because of greater simplicity, economy and more rapid heating.

The De La Vergne Machine Co., New York City, are installing at the E. & G. Brooke Iron Company's plant, Birdsboro, Pa., refrigerating machinery of 350 tons capacity, to be used in drying the air blast for their furnaces. Much interest has been aroused among blast furnace men by this new method in which the air is passed over coils of pipe containing cold brine or ammonia. Part of the moisture contained in the air is deposited on these pipes, the part remaining being practically constant so that the humidity of the blast is uniform. Among other important benefits derived from using a dry air blast of uniform humidity are improvements in the quality of iron and greater economy and efficiency in the operation of the furnace. Messrs. Frank C. Roberts & Co., Philadelphia, Pa., are the engineers.

JAPAN'S GROWING INFLUENCE IN CHINA.

Mr. Fraser, the British counsul-general at Hankow, warns the British public that the present foreign trade of Great Britain with China will only be maintained with the utmost difficulty. The spirit of opposition to foreign enterprise in the country, he says, is now manifesting itself among all classes of

the Chinese people after a fashion that does not admit of two interpretations. The foreigner from the West is to no longer enjoy the privileged position in regard to land concessions or trade facilities to which he has so long been accustomed. Japan appears to figure considerably in this change of things. The Chinese former dislike for the Japanese, according to Consul Fraser, has been transformed into keen admiration, and the latter has now the advantage not only of his geographical position, but of his kinship and similarity in thought and custom, which particularly fit him for penetrating into the interior and pushing his wares in the shops and towns and villages of China whence no one ever visits a treaty port.

NEW PROCESS OF TURNING ORE INTO IRON AND STEEL.

D. H. Ross, Canadian commercial agent at Melbourne, reports that two Australian inventors have discovered a new process for the continuous treatment of iron ore, and he says that the results they have achieved are so successful that the process is to be exploited throughout the world.

It is called the Heskett-Moore process for directly converting iron ore into malleable iron or steel by a continuous system, and it is claimed effects a saving of 25 per cent. in the manufacture. The ore is simply concentrated by ordinary methods, or if it is magnetic it is separated electrically until the pure oxide of iron is obtained. The oxide of iron is passed through a revolving cylinder heated by waste gases from subsequent operations and brought in that cylinder to a dull read heat. It drops from the cylinder to a second similar cylinder, and in the latter it is brought into contact with the deoxidizing gas, which is forced through and brought into contact with the heated ore. The heated ore is thus converted into a pure iron. Accompanied by and protected by the deoxidizing gas, it is passed into a third chamber or melting hearth, where it falls into a bath of molten iron and is converted directly into steel or balled up as malleable iron.

The savings claimed for the process are those of time, labor—the whole process being automatic—fuel, and avoidance of flux. The inventors claim that they have discovered a direct method of producing steel from one operation instead of using the blast furnace and converter.

PRACTICAL ITEMS for PRACTICAL MEN.

THE following data relating to water will be found useful in making calculations for the capacity of pumps:

Cubic feet × 62 = pounds.
Pounds ÷ 62 = cubic feet.
Gallons × 8.33 = pounds.
Pounds × 0.12 = gallons.
Cubic feet × 7.5 = gallons.
Gallons × 0.134 = cubic feet.

These figures will vary slightly for different temperatures, but are sufficiently accurate for ordinary use.

In general underground work, the use of iron columns or bars, to which the rock-drill is fastened by clamps, slips, etc., is decidedly the best. The use of the single-screw bar or column in stopes, drifts, etc., of small dimensions is preferable. In large excavations the double-screw column, with swinging arm upon which the machine is mounted, is good, and has many valuable advantages auxiliary to cheap mining.

Cylinder cooling in the alcohol engine is considerably simplified as compared with cooling the cylinder of a gas or other type of internally fired engine by the fact that the flame of burning alcohol radiates heat less rapidly than that of gasolene or other internal-combustion fuels. Consequently less of the heat of combustion is communicated to the cylinder walls to be removed by the cooling jacket.

The most efficient way of dealing with scale is to prevent it from entering the boiler, which may be done by passing the water through a purifier. Here the water comes in contact with either exhaust steam or live steam from the boiler and its temperature is raised until the carbonates and sulphates are precipitated. The water then passes on to the boiler while the scale stays behind in the purifier, from which it may be removed without trouble. What scale gets into the boiler may be removed by blowing off.

To obtain a private water supply a deep well is often driven until a sufficient quantity is obtained. As the well is driven, an 8-in. pipe is sunk to form the casing. When the water-pocket has been reached the water will usually rise and stand in the pipe several hun-

dred feet above its bottom, and the amount of water that can be usually pumped from such wells, without lowering the water, is practically unlimited. The cost of drilling deep wells per foot of depth including the casing, is for a well with 8-in. casing, $4.50 per foot.

Pneumatic locomotives are employed in some of the large German collieries. The engine is constructed like an ordinary steam locomotive. An air-storage tank takes the place of the boiler. The air is stored under pressure varying from 700 to 1,000 lb. per square inch. In some of the engines the air passes into an auxiliary reservoir before entering the cylinders. The air pressure is reduced to about 150 lbs. per square inch before entering the engine cylinder. The air is used expansively by means of the Stephenson link-motion gear. This system of underground haulage is cheaper and handier than rope haulage, and it is thoroughly safe and reliable.

In a wet mine, where a shaft is not conveniently available and it is desired to clear the workings of water, a bore hole may be driven to the surface of the water and a pipe driven far enough beyond to secure proper submergence; the water can then be lifted by means of compressed air. The expense of driving a shaft is thus saved and the water lifted at a comparatively low cost.

Compressed air is still more extensively used than electricity as the motive power for coal-cutting in Great Britain. In 1905 there were 555 compressed-air machines, while only 355 electric machines were in use. However, the latter are making greater strides than the former, for out of the year's increase in the number of machines in use, 85 were driven by electricity and 70 by compressed air.

The principal causes of loss in steam plants are the use of engines which are overloaded, undersized or badly arranged steam and exhaust pipes, and imperfect condition and poor operation of boilers. In many plants exhaust steam, which might be utilized for heating, is wasted. This is the most economical use which can be made of it; but if the back pressure be raised excessively to force the steam through the pipes, this advantage may be lost. To obviate this a vacuum system, taking only a small amount of power for its operation, should be used to draw the steam and water through the pipes.

The rate of air flow under a given pressure difference is proportional to the density or specific gravity of the fluid. A pressure of 1 oz. per sq. in. will create in the case of water only a sluggish stream. In the case of air, which is more than a thousand times lighter, the velocity will be as high as a mile a minute. For ventilation, this pressure and velocity are seldom exceeded, and efficiency of movement is sought in their reduction to the minimum consistent with the cost of the passage or conduit of greater area.

The rock-drill that performs the most work in the shortest time, at the lowest cost and consumption of air, and whose parts will stand the roughest usage, wear longest and are the least expensive to replace is the best machine to choose. The matter of first cost is not worthy of consideration, because an inferior rock-drill is a source of constant expense and serious loss, and when discovered should be immediately thrown out on the scrap heap.—*Engineering and Mining Journal.*

A new compound for pipe joints has been introduced in France. It is free from all the inconveniences of red lead. The new putty is composed of zinc gray and a Chinese vegetable oil utilized in England for manufacture of linoleum and some kinds of varnish. The material hardens completely at 150 deg. C., and at 110 deg. C. in six hours. This putty is said to be cheaper than red lead, and is of less density.

The air compressor and the rock drill have accomplished as much for the quarrymen as the magnetic needle did for the mariner or the tabulation of multiplication for the arithmetician. It has simply made easy what was before the impossible, and the end is not yet, for the improvements of pneumatic tools, for every branch of the stone industry are still advancing apace. It is indeed interesting to talk to the old-time quarryman who recalls the day when blasting was the only means for loosening the stone (with nearly every shot wasting fully 70 per cent. of the ledge broken off) and hear him relate vividly the actual comparison with modern quarry methods.—*Rock Products.*

CHIPPINGS.

ENOS Ayres, son of the well-known mining expert, H. R. Ayres, deceased, has joined the Traylor Engineering Co., as Engineer Salesman in the New York City district.

Mr. H. R. Ayres, during his lifetime, was known all over the Southwest as being one of the most successful and learned mining men in that part of the country, and his statement was enough to decide the method of treatment necessary for the recovery of all values possible from different characters of ores.

Mr. Enos Ayres has had the benefit of his father's training besides serving an apprenticeship in various mines and mills of Colorado and Utah. Mr. Ayres has had the advantage of a technical education, and is thoroughly competent to advise mining men as to what character of plant or machinery will successfully treat their ores.

Mr. Ayres will make his headquarters at the Company's offices, No. 114 Liberty Street, New York.

The shovel used in excavating the mass of the material removed in building the tunnel for the new Union station, at Washington, D. C., is operated by compressed air. By the use of these appliances all smoke and gases are avoided, allowing the workmen to perform their labors under the most favorable conditions without adding materially to the cost of construction. The remainder of this work consists of cut and embankment, with bridges over the intersecting streets. At the present rate of progress this work will be completed ready for use by the end of the year, though it has not been definitely decided when it will be put in service.

The object of piston valves originally was to take the place of large slide valves which could not be made tight and were therefore ineffective. In action the piston valve decreases the friction and increases the port opening for the same space occupied by the valve. A typical shape of a piston valve is a D slide valve wrapped in the form of a cylinder.

LIQUID AIR HIGHBALLS.

A story comes from London, by way of a special cable to the New York Sun, of liquid air as a substitute for ice in the concoction of cooling beverages. The process of liquifying air, it seems, has been so cheapened that it can be supplied for $1.25 a gallon, and a method of keeping it in a vacuum for seventeen hours has been devised. It is stated that a few drops in a highball will dance about like diamonds, give out a white mist, form into minute lumps of ice, and finally dissolve. The process takes about two minutes, at the end of which time the drink is deliciously cool. Patrons of the bar are advised, however, to wait for the liquid air to evaporate, lest the consequences be "pathetic" for themselves and "humorous" for the spectators. We should imagine that "tragic" and "shocking" would better fit the supposed situation. The stuff if something that cannot be fooled with to any great extent, being a candidate for honors with the buzz saw and the X-ray as resenters of undue familiarity. Still, liquid air, cautiously handled, may yet come into prominence as a club with which to smite the extortionate ice trust.

RAIL PRODUCTION.

An interesting review of the world's rail production appears in the last issue of *Engineering*. It shows that the annual rail production throughout the world is now estimated at 7,250,000 tons. In this aggregate American rails figure for 3,500,000 tons, British rails for 1,000,000 tons, German rails for 1,000,000 tons, Belgian rails for 350,000 tons, Russion rails for 500,000 tons, and French rails 300,000 tons. The odd 600,000 tons are made in Canada, Italy, Spain, Japan, China, Austria, &c. Even now it is by no means certain that the maximum output has been attained, as many countries are still developing their means of production. Our contemporary points out that during fourteen years ending 1894 the United States trebled their rail output. The rail production of Germany was also doubled in the same period; but this did not prevent Canada, Italy, Japan, Austria, &c., from making rapid progress in the same direction. The greatest consumption of rails appears likely to be now witnessed in Canada, British India, Australasia, and Africa. Russia has by no means completed her railway network; she has a terri-

tory double that of the United States, and her population exceeds that of the United States by some 70 per cent. But the political and economic condition of the Tsar's empire is just now by no means calculated to encourage fresh Russian railway enterprise. China will probably be a large consumer and possibly also an important producer of rails, as the Chinese authorities are giving considerable attention to the work of railway establishment. The same may be said of Japan.

PUMPS IN FRANCE.

Demonstration Needed to Secure Sales.

Consul-General Robert P. Skinner, of Marseille, reports that he has received requests from many correspondents in the United States for names of first-class firms in France who might be induced to take a general agency for American pumps and hydraulic machinery. The consul-general writes:

There are a number of such firms in this city, and I have communicated directly with several of them.

In each case it turns out that these houses already represent either American or French pumps, and therefore have no disposition to take on any other competing line. They could be interested, therefore, only if the American manufacturers visited this city, and demonstrated the superiority of their particular pumps. To discover properly equipped firms or individuals, not already engaged in this business, without the special knowledge which only manufacturers possess, is exceedingly difficult.

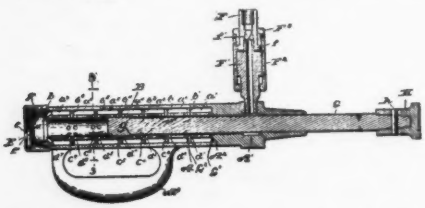
The information obtained in this connection merely confirms statements frequently made heretofore, namely, that attempts to build up an export business by correspondence and without the introduction of the personal element in the initial stages are rarely satisfactory. If my correspondents should visit this city, inspect local stocks, and visit innumerable firms and individuals whom I might mention, it is altogether probable that results would follow, but by an exchange of letters a successful issue is far less probable. There is a considerable demand for pumps on the part of shipbuilders at La Seyne and at Port de Boue, where the shipbuilding plants are located. In the city special pumps are required by manufacturers of chemical products and acids. Manufacturers of oils and soaps are also buyers of large pumps, the price of which approximate $579 put in place, this statement being too vague, of course, to convey any real information. There are, furthermore, in this region numerous coal, lead and bauxite mines and stone quarries, in all of which power pumps are required. As several of the standard American pumps are already on sale in this market, it goes without saying that other American firms would have no greater difficulties in overcoming the tariff rate of 25 francs per 100 kilograms ($4.82 per 220 pounds) on ordinary pumping machinery.

Some large steamers are now being built to be propelled by Curtis steam turbines. The cruiser Salem, for the United States navy, is 420 ft. long; displacement, 3,750 tons; designed speed, 24 knots; horse-power, about 16,000, 350 r. p. m. The Southern Pacific's Creole, 415 ft. 8 ins. long; displacement, 10,160 tons; designed speed, 16 knots; will require about 8,000 h. p.; revolutions, about 250. Her turbine will be one-half the weight of engines.

A pecularity about the farmers of Wuhu, China, is that they will accept in payment for rice and other products only Spanish dollars dating back to the last decade of the eighteenth and early nineteenth centuries. These dollars, although in purity no better than, and in weight not equal to, the Mexican, are at a considerable premium, which fluctuates almost daily. It is believed that there are in all about 4,000,000 dollars in the province of Wuhu, of which not more than 1,700,000 are in circulation, the remainder being hoarded by the peasantry.

There are several ways of classifying engines. They may be classified according to the style of cut-off; positive cut-off engines in which the steam is cut-off at the same point in each stroke of the piston, the admission of steam from the steam pipe to the steam chest being controlled by the governor; adjustable cut-off engines in which the point of cut-off can be adjusted by the engineer at his pleasure by means of a screw, hand-wheel or reverse lever as in the case of a locomotive; automatic cut-off engines in which the governor controls the valve gear so that the admission of steam direct to the cylinder is governed instead of to the steam chest as in the case of the positive cut-off.

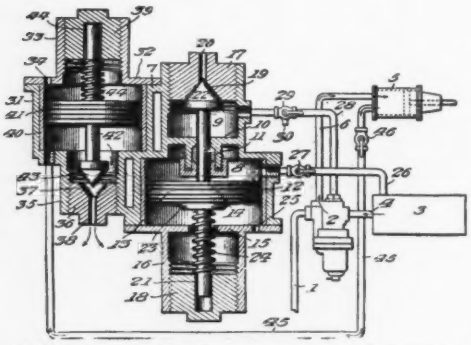
826,106. FLUID-PRESSURE-OPERATED TOOL. CHARLES H. JOHNSON, Chicago Heights, Ill., assignor, by mense assignments, to The Pittsburg Pneumatic Company, Canton, Ohio, a Corporation of New Jersey. Filed July 24, 1902. Serial No. 116,835.



Claim.—In a fluid-pressure-operated tool of the valveless type, the combination with a cylinder, of a reciprocating piston therein, said cylinder having motive-fluid supply and exhaust ports and passages for automatically terminating the stroke of the piston relatively to the cylinder upon the piston engaging an object.

826,249. APPARATUS FOR SEALING CANS, JARS, AND OTHER PACKAGES BY ATMOSPHERIC PRESSURE. CHARLES C. HOVEY, Bainbridge, N. Y. Filed July 15, 1905. Serial No. 269,820.

826,322. AIR-BRAKE SYSTEM. DAVID FELTEN, Parsons, Kans. Filed Nov. 25, 1905. Serial No. 289,139.



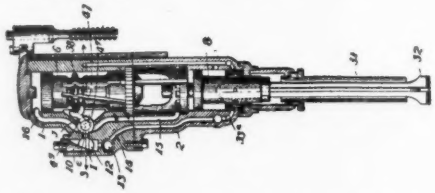
Claim.—In an air-brake system, a regulating-valve comprising a casing having two chambers separated by a partition, one of said chambers being provided with an outlet-port, a stem arranged in said chambers and sliding through said partition, a diaphragm arranged within the other chamber, means for subjecting the diaphragm to pressure on its side adjacent the partition, a spring acting on the opposite side of the diaphragm in opposition to such pressure, means for connecting the other chamber with the exhaust-port of the triple valve, and a valve carried by the stem and operating in said chamber to close the outlet-port therein.

826,330. AIR-CUSHIONING HEEL OR PAD FOR BOOTS OR SHOES. EDWARD N. HAAG, West Philadelphia, Pa., assignor to Ferdinand H. Duckwitz, Philadelphia, Pa. Filed July 27, 1905. Serial No. 271,398.

826,353. COUPLING-RETAINING MEANS FOR METALLIC HOSE. RICHARD B. PAINTON, Williamsport, Pa., assignor of one-third to Jacob Hess Bailey, Muncy, Pa., and William Bailey, Jersey Shore, Pa. Filed Aug. 4, 1905. Serial No. 272,753.

826,397. PNEUMATIC COUPLER. FREDERICK L. WOOD, Worcester, Mass., assignor to The Aeolian Company, New York, N. Y., a Corporation of Connecticut. Filed Oct. 28, 1905. Serial No. 284,864.

826,456. ENGINE FOR ROCK-DRILLING MACHINES. CASSIUS M. WALKER, Pueblo, Colo., assignor to The Walker-Moore Rock Drill Manufacturing and Supply Company, Pueblo, Colo., a Corporation of Colorado. Original application filed Nov. 28, 1904. Serial No. 234,608. Divided and this application filed April 1, 1905. Serial No. 253,301.



Claim.—The combination with the cylinder of a rock-drilling machine and with its ports and tapering valve-socket closed at each end, of a tapering valve fitted to said socket, provided with two heads and an intervening web, the ports communicating with the space between the heads, a chamber beyond the larger head of the valve, a port in said head, a socket in the smaller head with separated shoulders below the same, and an arm with a head fitted to said socket and extending between the shoulders to have a limited motion independently of the valve for rocking the latter, substantially as set forth.

826,490. TIRE. JAMES H. SWAIN, Pittsburg, Pa., assignor, by mense assignments, to H. M. & S. Armored Tire Company, Incorporated, Pittsburg, Pa., a Corporation of Pennsylvania. Filed July 25, 1905. Serial No. 271,184.

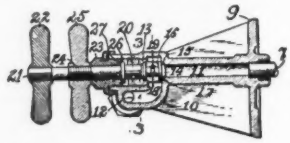
826,530. AUTOMATIC FLUID-PRESSURE REGULATOR. ROLLO R. BELL, Chickasha, Okla., assignor of one-half to Wilson P. Bell, Ceres, N. Y. Filed Jan. 29, 1906. Serial No. 298,488.

826,555. VALVE FOR ICE-MACHINES. FREDERICK W. FELSBERG, Dayton, Ky., assignor to The Triumph Ice Machine Company, Cincinnati, Ohio. Filed June 14, 1905. Serial No. 265,150.

826,612. TIRE. WILLIAM B. SAWYER, Riverside, Cal., assignor of one-third to S. G. Armstrong, Riverside, Cal. Filed Dec. 5, 1905. Serial No. 290,461.

826,623. PNEUMATIC TIRE. JAMES A. SWINEHART, Akron, Ohio. Filed Oct. 25, 1905. Serial No. 284,272.

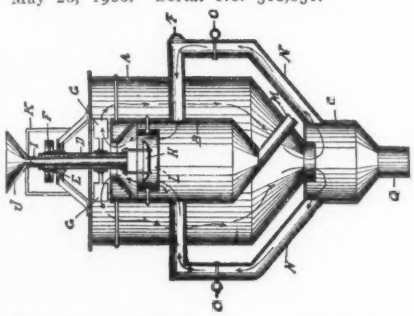
826,649. CUT-OUT VALVE FOR FLUID-COMPRESSORS. NIELS A. CHRISTENSEN, Milwaukee, Wis. Original application filed Sept. 9, 1899. Serial No. 729,957. Divided and this application Dec. 11, 1899. Serial No. 739,899.



Claim.—A cut-out valve for compressors comprising a valve-casing provided with a valve-chamber having an inlet from the compressor and also having an outlet, a valve in such chamber governing the communication between the inlet and outlet, a screw-threaded body arranged to screw upon the inner wall of the casing and upon which said valve is rotatably mounted, a longitudinally-movable stem coöperating with said body to rotate it, and a collar arranged on said stem to seat upon an inner wall of the casing.

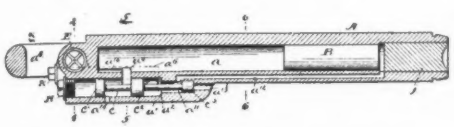
826,725. MACHINE FOR DELIVERING LIQUIDS. Alexander F. Humphrey, Allegheny, Henry McCrory, Wilkinsburg, and Frank D. Saupp, Jr., Pittsburg, Pa. Filed June 7, 1905. Serial No. 264,113.

826,772. AIR-SEPARATOR. George S. Emerick, Philadelphia, Pa. Filed Jan. 5, 1905. Renewed May 26, 1906. Serial No. 318,831.



Claim.—In combination, in an air-separator, an outer casing, an auxiliary chamber joined to and communicating with the outlet of said outer casing, an inner casing disposed within said outer casing, and a plurality of pipes forming a connection between said auxiliary chamber and said inner casing, substantially as and for the purposes described.

826,780. BRAKE-SETTING DEVICE. Ellsworth Godley, Springfield, Ill. Filed Feb. 16, 1906. Serial No. 301,476.



Claim.—In a pneumatic tool, a barrel, a valve-casing on the outer side thereof parallel therewith and bored out tubularly from the head end of the tool, a screw-plug for closing said casing accessible from the head end of the tool, an automatic piston-valve in said casing, three passage-ways from said casing to the main bore of the barrel, combined with a second casing formed transversely at the head of the barrel, an admission-valve in such second casing, a looped handle for the tool formed beyond the second casing, means conveniently accessible at said handle for operating the admission-valve, and a passage-way formed along the wall of the barrel between said two casings, substantially as described.

826,833. PNEUMATIC ACTION FOR MECHANICAL MUSICAL INSTRUMENTS. William F. Cooper, Norwalk, Ohio, assignor of one-half to The A. B. Chase Co., Norwalk, Ohio, a Corporation of Ohio. Filed June 10, 1905. Serial No. 264,674.

826,885. ELASTIC-FLUID TURBINE. Richard H. Rice, Swampscott, Mass., assignor to General Electric Company, a Corporation of New York. Filed Jan. 23, 1906. Serial No. 297,396.

826,927. ELASTIC-FLUID TURBINE. James W. Ferguson, Sandusky, Ohio. Filed May 9, 1906. Serial No. 315,972.

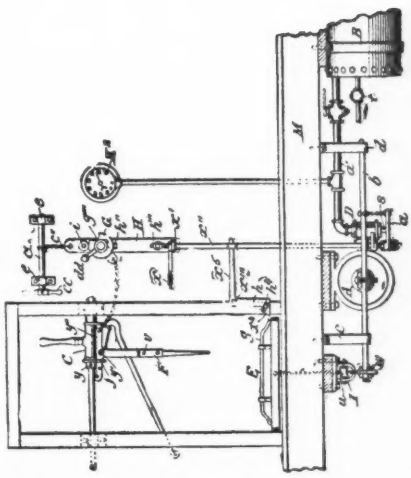
826,941. ELASTIC-FLUID TURBINE. Oscar Junggren, Schenectady, N. Y., assignor to General Electric Company, a Corporation of New York. Filed Jan. 2, 1906. Serial No. 294,295.

826,979. VALVE-CONTROLLING MECHANISM. James Wilkinson, Providence, R. I., assignor to Wilkinson Turbine Company, a Corporation of Alabama. Filed July 3, 1905. Serial No. 268,203.

826,981. VALVE MECHANISM. James Wilkinson, Providence, R. I., assignor to Wilkinson Turbine Company, a Corporation of Alabama. Filed Sept. 23, 1905. Serial No. 279,810.

827,021. AIR AND VACUUM MOTOR. George W. Johnson, St. Joseph, Mo. Filed Jan. 23, 1904. Serial No. 190,304.

827,056. MAIL RECEIVING AND DELIVERING MECHANISM FOR RAILWAYS. Franklin H. Burr, Atlantic, Iowa, assignor to Railway Mail Equipment Co., Beresford, S. D., a Corporation. Filed Dec. 16, 1905. Serial No. 292,055.

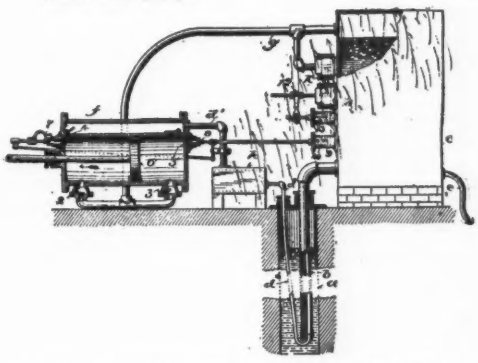


Claim.—In a delivery mechanism for railway-cars, the combination of a delivering-frame having a pivotal attachment to said cars, a compressed-air-operating cylinder having a piston pivotally attached to a swinging operating-lever, which is pivotally attached to said cars, and to said delivering-frame, and means for automatically swinging said lever whereby said delivering-frame is tilted and dumped, substantially as set forth.

827,060. AUTOMATIC SAFETY DEVICE FOR FLUID-COMPRESSORS. James W. Dawson, San Francisco, Cal., assignor of two-twelfth to George Beagley, San Francisco, Cal. Filed Dec. 31, 1904. Serial No. 239,254.

827,063. AIR-BRAKE APPARATUS. Albert H. Geltz, Alliance, and Lee L. Hosack, Youngstown, Ohio, assignors to C. B. McLean, Pittsburg, Pa. Filed April 1, 1905. Serial No. 253,342.

827,341. LIQUID-RAISING APPARATUS. George R. Young, Ridgewood, N. J., and Clifford Shaw, New York, N. Y., assignors to Bacon Air Lift Company, a Corporation of New Jersey. Original application filed Feb. 1, 1899. Serial No. 704,104. Divided and this application filed Jan. 18, 1902. Serial No. 90,292.



Claim. In combination, an air-compressing mechanism, an uptake for liquid, a downtake air-pipe conveying air from the compressor to the said uptake, a pressure-supporting separating-chamber into which the said uptake passes, a water-discharge passage leading from the separating-chamber and discharging against a static or dynamic resistance, an air-pipe leading from the said chamber to the said compressing mechanism, and means controlled by the static pressure of the liquid in said chamber for introducing additional air into the system.

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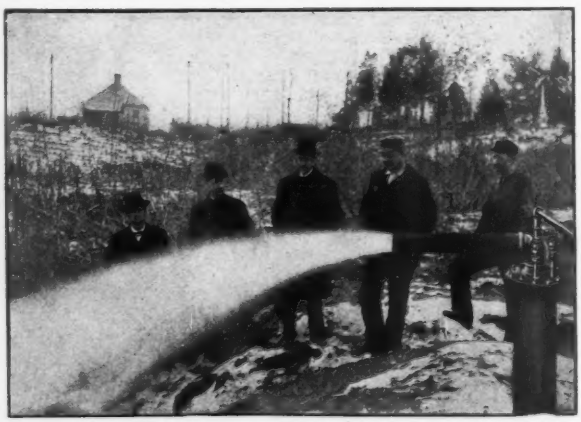

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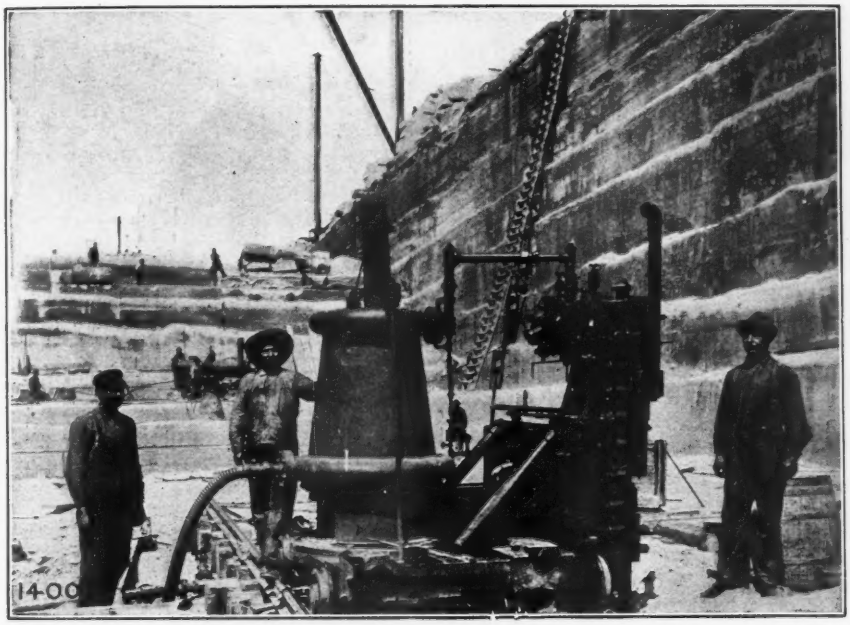

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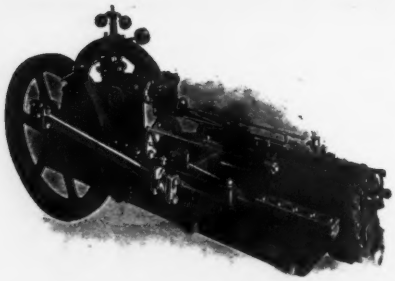

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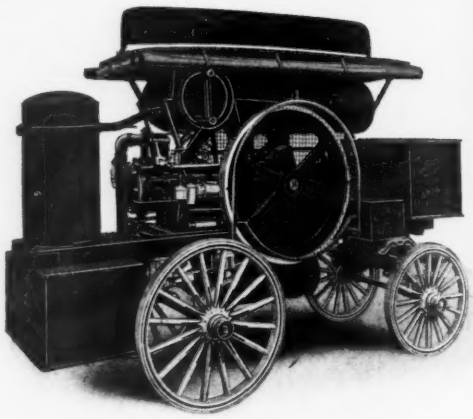

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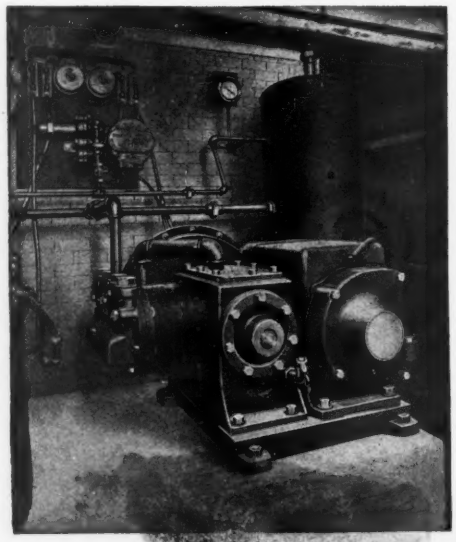

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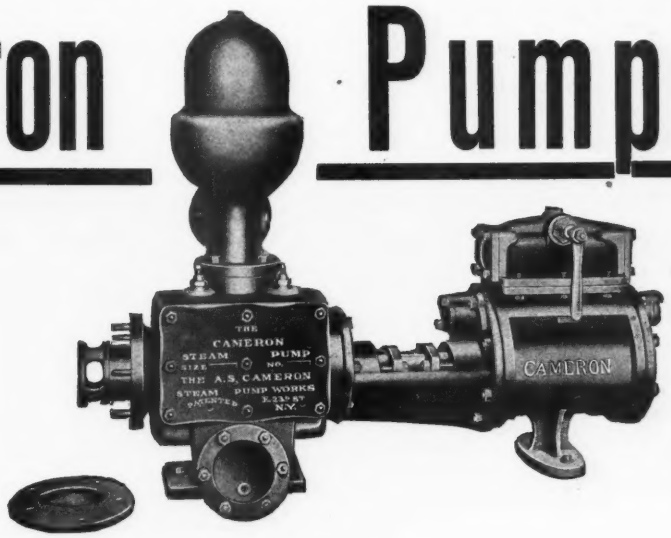

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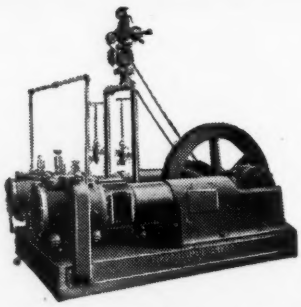

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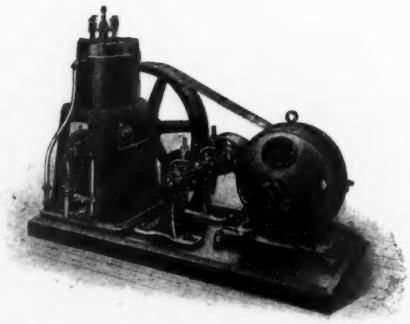

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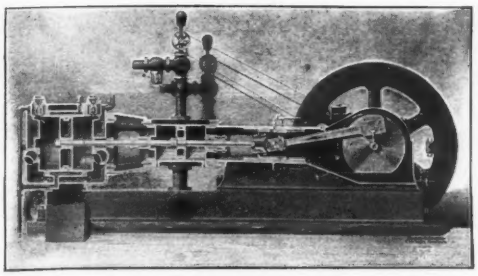

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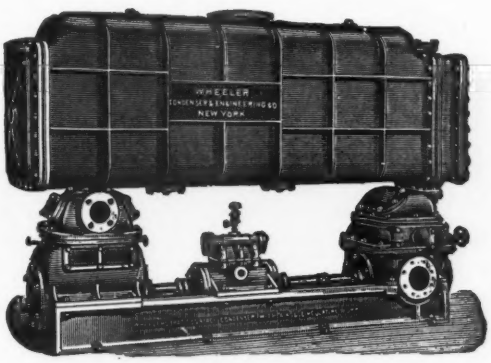

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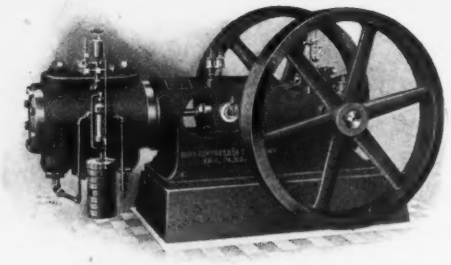

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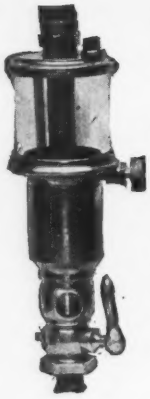

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INDEX TO ADVERTISERS.

American Diamond Blast Co.	11
Blaisdell Machy Co., The	5
Boiler Maker, The	14
Brown & Seward	5
Browning's Industrial Magazine	18
Brownlng Press	11
Bury Compressor Co.	9
Cameron Steam Pump Works, A. S.	4
C. R. R. of N. J.	15
Chicago Pneumatic Tool Co.	Back Cover
Clark Co., The W. J.	Back Cover
Cleveland Pneumatic Tool Co.	11
Cooper Co., C. & G.	Front Cover & 10
Coal	19
Comstock Engine Co.	9
Curtis & Co. Mfg. Co.	5
Davis & Davis	3
Druckleib, C.	5
Engineers' Club	19
Engineering Contracting	1
Engineering News	19
Engineering Magazine	13
Engineering World	16
Engineers' Review	17
Fiske Bros. Ref'g. Co.	Inside Cover
General Compressed Air House Cleaning Co.	3
Goodrich Co., The B. F.	7
Hanna Eng. Works	9
Ingersoll Rand Co.	2 & 8
International Press Cl'p'g. Bureau	18
International Correspondence Schools	13
Lidgerwood Mfg. Co.	Inside Cover
Luce's Press Clip'g Bureau	15
McKiernan Drill Co.	3
Marine Engineering	18
Modern Machinery	18
Mines and Minerals	13
Porter Co., H. K.	7
Powell Co., W. M	3
R. R. Gazette	14 & 16
Rix Compressed Air & Drill Co.	Back Cover
Romeike Hy.	15
Sargent Steam Meter Co	11
Sprague Electric Co.	1
Stearns-Roger Mfg. Co.	12
Sullivan Machy. Co.	6
Traylor Engineering Co.	20
U. S. Press Clipping Bureau	15
Westinghouse Trection Brake Co.	3
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Wiley & Sons, John	18

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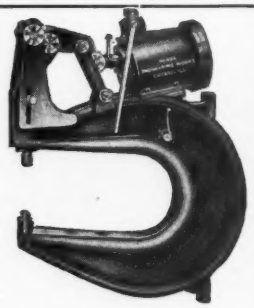

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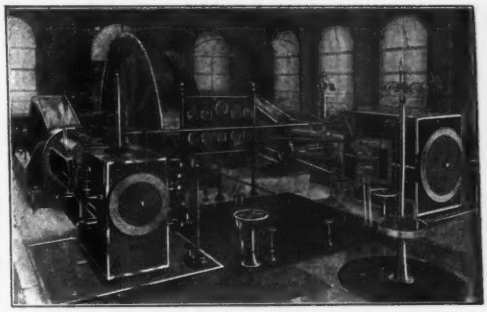

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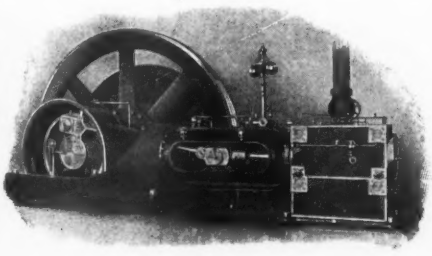

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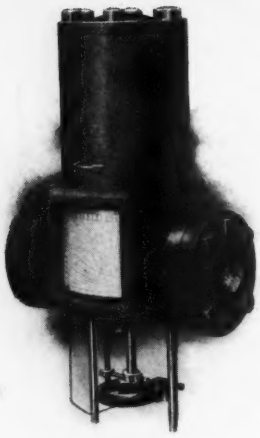

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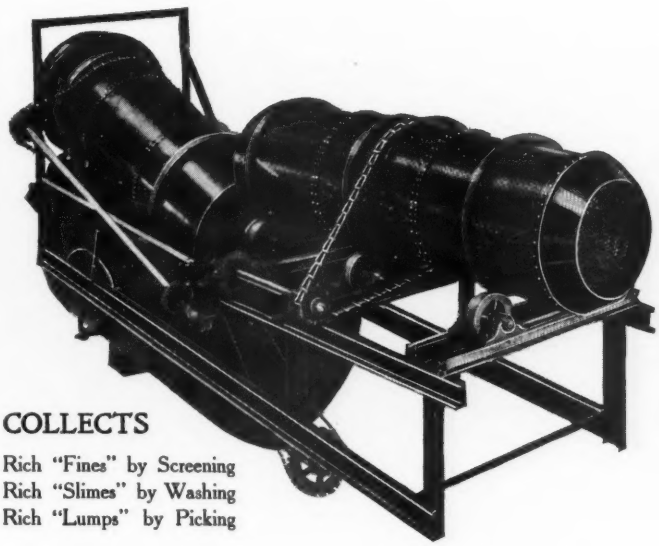

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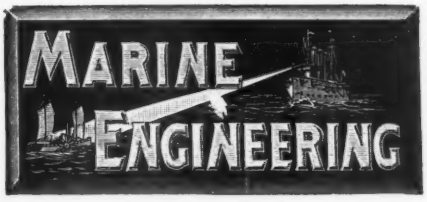

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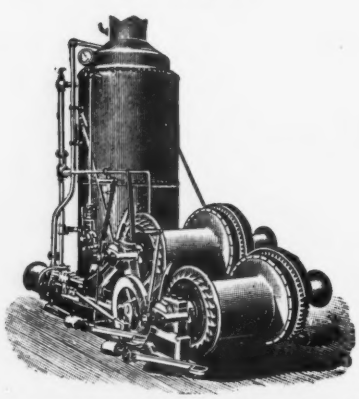

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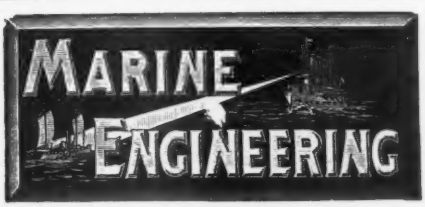

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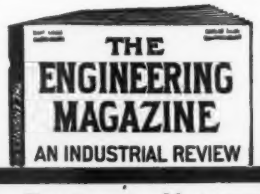

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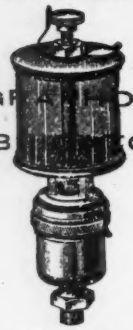

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